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JOURNAL,

SCIENTIFIC AND RAILWAY GAZETTE.

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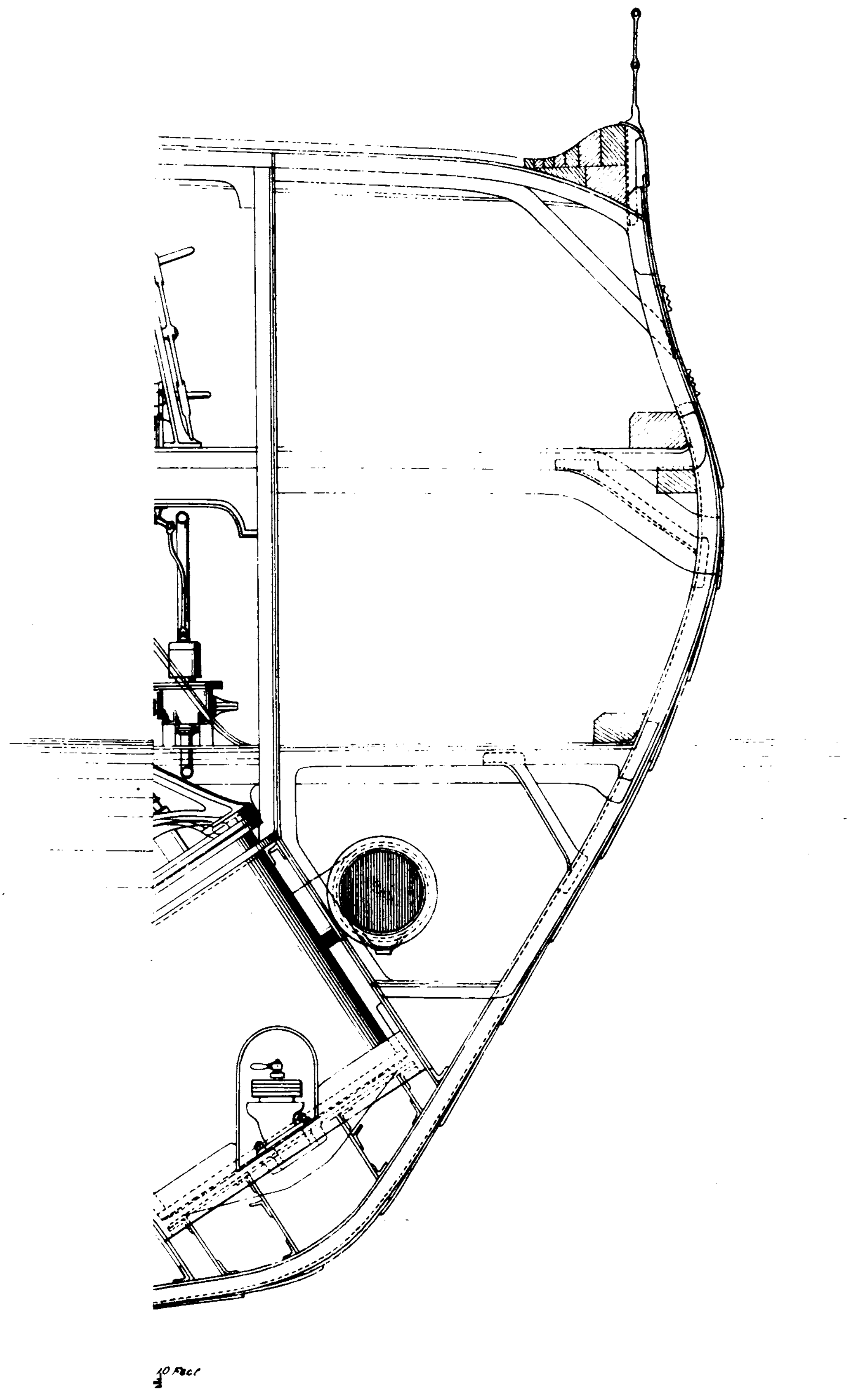
INDEX TO VOL. IX.

LIST OF ILLUSTRATIONS.

DIRECTIONS TO BINDER.

Plate 1.



537/P

THE

CIVIL ENGINEER AND ARCHITECT'S JOURNAL,

INTRODUCTORY NOTE.

In commencing the 100th Part, and a new volume of this work, the conductors of it venture upon a few introductory remarks; the object proposed is not, however, merely to offer the courtesies of salutation, though, were it no more, we might well be excused—at a season of universal greeting and goodwill—for expressing to those who have accompanied us, and those who have assisted us in the prosecution of our task, with how much gratification we arrive at this epoch of it, and commence a new portion of our labours.

In a periodical devoted, not to the general purposes of literature, but to the publication of information on specific subjects, and these of a very extended and frequently complicated nature, the reader has a right to expect that the mode of selecting and communicating information should be guided by certain fixed principles; for it is certain that, were no other rules adopted in conducting such a work as this, than that of setting down whatever appears to possess a passing interest, and that of recording the information just as it is supplied to us, the reader would no longer find what he would most anxiously seek for in these pages, professional information selected for its intrinsic importance, and referred to certain fixed principles as tests of its value and accuracy.

In Engineering, the first branch of our labors, it is by no means difficult to explain the rules here adopted. The theory of the operations of the engineer belongs, fortunately, to a philosophy the most accurate and complete, of all which the range of human thought encompasses—the philosophy of motion and equilibrium; and the application of this philosophy to practical mechanics is founded on a system of experimental knowledge, far exceeding in extent and the uniformity of its results all that has been obtained in other practical arts. For while, on the one hand, none of the operations of nature have been so successfully theorised as the mechanical, and on the other, none have been made so generally the subjects of practical industry.

In examinining, then, the labours of the engineer and mechanist, we have first to see how far their notions accord with the pure theory; secondly, how far the details of their works stand the test of experience. There once prevailed, unfortunately, an idea that the theory and practice of mechanics were inconsistent with each other; but the new and constantly increasing requirements of modern engineering are now fast dissipating the error; for, while the theoretical student finds it impossible to render his knowledge available without actual experience, the practical operator frequently finds, from the rapid advances of modern engineering, that he is placed in circumstances altogether new to him—discovers that his notions of the laws of mechenics picked up here and there, without any system, and generally mixed up with a vast amount of extraneous matter will not always suffice, and that he must frequently submit his judgment, in a measure at least, to that af the theorist.

It is quite true that the actual operations of engineering generally depend on natural laws so complicated as to render direct mathematical investigations, either impossible, or rendered possible only by hypothetical simplifications of the cases examined. It is not, therefore, to the immediate results of mathematics, that we are to look for the most general benefit derivable from pure theory, though even here how much has been done for the assistance of the engineer, labours such as those of Coulomb, Poncelte, De Pambour, Hodgkinson, Moseley, and Professor Willis amply testify. But there is another far more common benefit which the engineer will derive from mathematical knowledge, which, if duly considered, ought to remove from the mind of the practical student all coldness and suspicion respecting the results of theoretical mechanics.

It is not to be expected that an engineer, however high his mathematical attainments, could determine, numerically, the velocity of every engine he constructs, the pressure on every tunnel, or revetement wall which he builds; but this is certain, that his mathematical education will have so *systematised* and *simplified* his mechanical conceptions, that he will examine his works far more critically than he possibly would, were his physical notions derived merely from his own experience or popular treatises. It may be unhesitatingly affirmed that the perspicuous general insight into the laws of mechanics, afforded by the study of mathematics, is not to be obtained by discursive reading and casual experience however extensive or varied in its nature. It were easy enough to give instances of men eminent for their practical labours, who, from lack of systematic knowledge, frequently utter notions the most confused on mechanical subjects; or—to refer to more immediate instances—we might, from our own pages, point out repeated cases of inventors obtaining patents for the supposed attainment of physical impossibilities.

That chief value of the mathematical theory of mechanics to the practical engineer would seem then to be, not so much the prediction of the exact result of his labours, as the general guidance afforded to him in conducting them—the knowledge by which, without the toil of experiment, he distinguishes between what is physically possible and what impossible, and is directed in choosing the mechanical appliances best suitable to effect his objects. Who can estimate how vast an amount of intellectual and experimental labour might have been saved, had those who so long long strove to discover "perpetual motion," and the means of making water raise itself, known that they were, in fact, striving to give to matter laws altogether diverse from those assigned to it in the economy of nature? And yet the same efforts (applied to different objects) are made in our own day. It may, therefore, be safely assumed that we cannot greatly err in recording the progress of engineering, if we constantly refer to pure theory as a test of the accuracy of our judgment—if we apply constantly the principles of mathematical philosophy divested of its language.—The language of symbols is requisite only in determining exact statistical results, but the general principles of pure mechanics are of universal application, and are capable of being expressed in ordinary language with a facility and accuracy far beyond what might be naturally anticipated, had we not eminent proofs that the attempt may be made with success.*

IN ARCHITECTURE the determination of fixed rules of criticism is not so easy a natter. Taste refuses to be fettered by the strict laws of natural philosophy, and the canons of the fine arts are seldom demonstrable. Still we have even here some fixed principles which rest on the safe foundation of universal consent, and are susceptible of very extended application. The general law that architectural beauty is dependent on utility was universally recognised by those from whom we borrow the only kinds of architecture adopted by us—the Classic and the Christian—and it is a law which at a time like the present, distinguished by a growing interest in the philosophy of the arts, few will be bold enough to controvert—the simple and indisputable rule that architectural members applied without use, or to wrong use, are deformities *per se*, will of itself frequently be sufficient in determining our judgment.

It is not however to be concluded that this principle is the only one which the Classic and Mediæval architects held in common; and it may here be remarked how little progress has been made in discovering the *abstract principles* by which these masters were guided. Of the actual *forms* adopted by them there has been no lack of study. The lines and dimensions exhibited by standard specimens of architecture have been noted down and catalogued with wonderful and praiseworthy minuteness. But may it not be doubted whether the neglect of principles for the sake of forms, savour not somewhat too strongly of servile coyping! An intelligent student-artist will, it may be fairly supposed, endeavour rather to become imbued with the spirit and genius of his master, than to reproduce every minute mark and characteristic of his works.

Here seems to be the real cause why some who in our own time have laboured zealously to restore one kind of architecture to its original purity, have failed of the full recompense of their talents, industry, and zeal. An indiscriminate adherence to precedent has produced its never failing fruits—bigotry and intolerance. Had the same labour which has been spent in recording proportions and copying outlines, been devoted to the examination of the beautiful philosophy of which those dimensions and proportions were the results, we should hear of few efforts to exalt one system of pure architecture at the expense of another, and we should probably have far advanced in reducing our knowledge of ancient architecture to a system by which alone we can hope to rival the masterpieces of that art of which we profess to be disciples.

But there may be some who would say further that we ought, not only to avoid servile adherence to precedent respecting architectural forms, but even to disown all obligation to be bound by the abstract principles of the old architects. To this it seems sufficient answer that in that case we must no longer profess to adopt the old modes of architecture; we must discover for ourselves some altogether new system. And though we have no warrant for denying *a priori*, the possibility of such a discovery, still until it be made—until we disown all similarity of our works to those of the classic and mediæval architects, we are clearly mere mimics, when we borrow from them some of the forms which they adopted, and apply them without any regard for their original purposes. This at least is certain that if we endeavour to confound together principles, which are not merely different, but directly antagonistic, the result must be discordant and inharmonious.

It surely were no difficult task to show that the genius of Greek and Gothic architecture are diametrically opposed to each other. Where we see the two brought into direct contrast (as for instance in the interior of a cathedral which the admirable taste of the last age has decorated with Corinthian columns,) the discordance is so offensive to the eye as to be immediately condemned. But why should we not carry the principles of the condemnation a little further, and condemn buildings when the details belong to the one system, and the outline to another system of architecture—buildings, for instance, in which it is enduavoured to give a lofty vertical effect by architectural members, which were originally proposed to produce a horizontal effect?

It is not to be denied that even where these considerations (indisputable as they seem,) have been neglected, there have been produced buildings, which, by the richness of their decorations, fail not of a certain claim on our admiration. But this is certain, that though the effect in such cases be gorgeous, it cannot, in the very nature of things, be pure. To copy such work is, at least, but to copy second-hand; and surely, if we be not going altogether wrong in our endeavours to purify our taste for Christian architecture, it is but a legitimate extension of our efforts to free classic architecture of the foreign ideas which have been imported into it. It may be, indeed, require a certain amount of adaptation, in the application to modern purposes; but the requirements of those who invented, and first used classic architecture, too nearly resembled our own to permit the supposition that the adaptation would involve a total subversion of their original principles.

These considerations will explain, with sufficient accuracy, the course we would endeavour to adopt with respect to the two leading divisions of our task. We make no profession, however, of being always able to attain the true philosophy of architecture and engineering. It is safe, sometimes, to simply record facts, and to wait until direct experience shews the value of them. In such cases, our labour is little more than that of compilation; and even where we undertake the more hazardous labours of direct criticism, we have frequently to confide in the consideration that our readers are, for the most part, those who are practically aware of the diversity and complexity of our task, and will make full allowance for the difficulties of it. At the same time, we are well persuaded of the importance of rendering all knowledge systematic; and we have this trust in the principles here set forth, that if they do not always lead to rapid discoveries of great truths, they will at least prevent the admission of great errors—that even if we sometimes loiter on our road, they will keep us from wandering altogether out of it.

ARCHITECTURAL DECEPTIONS.

To restore to architecture the excellence which it attained in the periods of its greatest purity among the Greeks and Mediæval Christians, it seems absolutely necessary that it should regain that hold on the popular mind which it possessed during those epochs. With the Athenians the erection of a temple, with our Christian forefathers, the building of a Cathedral was a work of no isolated or merely local import, but one which engaged the interests and tasked the energies of a whole nation. Whiel printing was not yet discovered, architecture, according to the beautiful theory of a great writer of our times, was the only method by which the mind of a people could express itself—and this at least is certain, and independent of all theory, that public architecture engaged far more of public attention heretofore than now. The slighest reflection will show that the national importance thus given to the constructive arts must have contributed much to their perfection and purity, and also, that on the other hand the very excellence of those arts, by re-action, greatly advanced the public estimation of them.

Nothing seems more fatal to the progress of architecture in modern times, nothing a greater obstacle to the resumption of its former rank than the custom which has unhappily crept into modern practice of using imitative and therefore deceptive materials. The feeling of honesty and candour which characterised the olden architects seems fairly out of date: and in its place we have almost universally a spirit of ostentation, an affectation of show, the dishonesty of pretension, the vulgarity of making things appear something different from, something better than, what they really are.

Where we cannot afford to build expensively, it would seem the best taste to use what humbler materials are at command honestly, and without any attempt at disguise; and to compensate as far as may be, for the want

* We may refer, in proof, to Airy's Theory of Gravitation, a work which exhibits in a most extraordinary manner the practicability of explaining, in ordinary language, the results of elaborate mathematical researches.

of more costly appliances, by simplicity and correctness of design. This rule ought at least to be observed in public buildings. For domestic architecture, the showy system of building is so nearly universal that it seems hopeless and useless to utter one word of protest against it at present. In this latter case there seems no better course than to wait patiently till another race of builders may arise too free from vulgarity to emulate the jackdaw in his assumption of the finery of the peacock. But with respect to public edifices the case is different, and against the building them of deceptive (and for the most part perishable) materials, a public protest ought to be decisively pronounced.

If it be desired to determine on what principles good taste universally decides against architectural imitations, the answer appears to be two-fold. In the first place deceptive materials are almost always less durable than those substances which they imitate; whereas one of the chief sources of the pleasure of viewing beautiful architecture is the consideration of its permanence. In admiring an ancient edifice, we shall find on analysing our own minds, that a great part of our gratification arises from the reflection that this very building, the object of our admiration, has been the wonder of many by-gone generations; and if, again, we are delighted by a noble work of modern architecture, our delight is in a great part made up from the consideration that we have bequeathed to posterity a worthy monument of the skill and intelligence of our own times.

But a second argument against architectural deceptions may be alleged which cannot be like the preceding one answered by the allegation that the deception may be made as endurable as the reality. An important source of the pleasure afforded by pure architecture is the recognition of the skill and energy of the architect. The curiously fretted roof and the elaborate window tracery delight, not only because of their intrinsic beauty, but because of the labour and patience exhibited on the part of the workman. If it were possible to conceive that these beautiful forms were ready made to the builder's hands by some fortuitous process, the feeling of admiration would be greatly moderated. In all master-pieces of architecture (and not of architecture only, but of all other noble arts) a distinguishing characteristic is that their full beauties are ascertained only by reiterated examinations. Every closer inspection serves only to reveal fresh instances of the skill and perseverance of the builder—but if these closer and more penetrating examinations should disclose traces of deception only, and want of candour, if we find that there has not been all that skill and perseverance bestowed which were promised at first view, the feeling of disappointment is proportionate to the former feeling of admiration, the mind retaliates by contempt of the juggle—retaliates in the same degree as it has been misled.

We have been led to make these observations by observing one of the most flagrant instances of the vulgarity of "make-believe" building which we remember to have ever met with. The fault is aggravated by appearing in Church-architecture, where, if any where, everything should be real. "The church at Platt," says the *Builder*, "is being erected from the designs of Mr. Sharp, who was the architect of a church at Lever-bridge, near Bolton-le-Moors, previously noticed, also built of *terra-cotta*. The plan consists of nave and aisles, chancel, a sacristy south of the chancel and a tower at the south-west of the nave. The style is decorated. The architect has probably had many restrictions to contend with, to which we may attribute the slightness of the internal piers, and increase of distance between the buttresses. The tower is united to the aisle by a lofty arch, which is worthy of praise. The church has more than the usual amount of decoration, and ornament is introduced with good effect in capitals and buttresses. The windows have two lights with foliated heads, and are, in the aisles, of two varieties. The design is evidently the production of a clever man, but we are compelled to express an unfavourable opinion of its execution.—Each separate piece of the terra-cotta is cast to the required form, and is much about the same size as a corresponding block of stone. Every piece is hollow, being, as it appeared, afterwards filled or backed up with concrete. *They are all nothing more than pots*, and from the trial we made, seem to have less cohesive power than brick. Nevertheless, they are made to support great weights. The piers of the church, which, as we have said, appear remarkably slender, are entirely composed of these pots. The plan is the clustre of four shafts. There are the usual defects incidental to the burning; parts of the mullions are out of the perpendicular, and the lines of the window-sill undulate in a very unsatisfactory manner. Indeed, the whole building, though good in design, and not deficient in ornament, will not bear a near approach. The face of each piece is scored with lines to imitate the tooling; and the mortar joints are large, and obtruding."

A church "built of terra-cotta"! Piers "composed of pots"! Lines scored "to imitate the tooling"! The faults of execution are not the only faults of such a building—are far outweighed the errors of principle which produced them. The notice which has just been copied is followed by some judicious general remarks—so judicious that we cannot but regret their brevity. "Unless *the skilful hand*" it is remarked, "be apparent, the result is disappointment rather than delight, and regret that the mind of the artist should have conceived it vain." Here truly there was no appearance of the *skilful hand*. Let us rejoice that it was un-skilful—otherwise perchance unskilful observers might have applauded an essay which the judicious would censure in proportion to its successfulness.

ARCHITECTURE IN MANCHESTER, LIVERPOOL, AND BIRKENHEAD.

SIR,—I resume my notices of the Building Arts in Manchester, and, having lately had opportunity of looking over some of the principal works going on in Liverpool and Birkenhead, propose adding a few remarks upon the progress there, which may be acceptable to your readers.

In my former letter I alluded to the proposed extension of the present MANCHESTER EXCHANGE, as designed to be carried into effect by Mr. A. W. Mills; since that time two great schemes have, with Mr. Mills's design, divided the attention of the public. The first was for an erection in Market-street and High-street, and a design of considerable merit was prepared by Mr. Gregan. The second scheme was to erect the Exchange on a site in Mosley-street, on part of which the Theatre Royal formerly stood. The latter seems now to have been decided upon, as on Thursday, Nov. 13th, the proprietors of the present exchange agreed to dispose of their buildings to the Mosley-street committee, on the condition that an Act of Parliament be obtained, in the next session, for the erection of the Exchange and other public buildings on the site in Mosley-street.

It is to be hoped that on this occasion an opportunity for public competition will be afforded to Architects, and doubtless the committee will have many first-rate designs sent in, from which they may select one which shall be an ornament to the town.

The head offices for the *Manchester and Leeds Railway*, at Hountsbank are advancing rapidly to completion, being raised to the level of the second floor. Much delay was experienced at first, owing to the unstable character of the ground on which the building is placed, and the architects, Messrs. Holden, have taken all proper precaution to have the foundations firm and secure, going down in some parts to a depth of 43 feet below the ground level. It is pleasing to notice instances of care and attention in foundations, as so many fine buildings are sadly deficient in this respect; as for example the Town Hall and the Athenæum in Manchester, both of which show cracks in stonework, arising from a sinking in the foundations. The erection for the head offices is built of Yorkshire stone, and the design is in the Italian Palatial style of architecture usual in the 16th century. The site is an irregular piece of ground, the principal front being 76 feet long, from which the building extends back about 96 feet. The height from ground line to cornice is about 42 feet, divided into two lofty storeys. The whole of the rooms in the basement is fireproof, and of very strong construction. Below the level of the ground floor windows is a broad tooled string course, under which is rustic worked masonry. In the centre of the principal front is a handsome Italian doorway, with the customary moulded jambs, dentelled cornice, trusses, &c. The ground floor windows, two on each side of doorway, have unusually bold broad moulded architraves; and the upper storey has Italian corniced windows; level with the bottom of the latter runs a moulded string course. A bold dentelled cornice will surmount the whole. The back parts of the erection are in rockfaced Yorkshire stone. These offices, with the arching over of the River Irk, will when completed materially improve the approach to one of the handsomest railway stations in the kingdom. The station for the Manchester and Leeds, and Manchester and Liverpool railways, which I allude to, ranks high as an engineering work, having two iron bridges of great span, and embankments of considerable height. The erection for refreshment and waiting rooms, offices, &c., are designed with a substantial simplicity and fitness, which we look for in vain in structures of greater pretension.

Warehouses.

A warehouse of novel character is near completion in Faulkner-street, for Mr. Dentith the drysalter. It has an elaborately worked stone front in the Grecian Doric style, and is the design of Mr. Thomas Fish Taylor, Architect. The width of frontage to the street is about 40 feet, and below the level of footpath are two cellar storeys, and above it four storeys.

The basement, up to the ground floor window sills, is of large blocks of Aberdeen granite, which from its hardness will resist any of those casualties which so frequently disfigure basements of our usual soft stone. The remaining height of the ground floor is built of faced Halifax stone, having segment headed windows and doorways. Above this floor are two pilasters and four three-quarter columns, fluted two-thirds down, and two stories in height, with suitable capitals. The windows are in the recesses formed by the columns and pilasters. The architrave, frieze, and cornice break round with the columns, and the frieze is enriched with a Grecian fret, deeply cut, and presenting a varied play of light and shade. Upon this cornice and over each column stand bold double pilasters of natural faced wallstone, with tooled bases and caps; on these, and on cantilivers between them, is the horizontal part of the pediment. The pediment spans the entire width, and would have had a much better effect, if more boldness of projection could have been obtained laterally: this, I suppose, is prevented from a fear of encroaching on a neighbour's territory. It is said that the original designs were for a fire-proof building, and it seems a pity that a building intended for the stowage of such combustible materials, and in the design and erection of which such pains and expense have been gone to (though I understand the whole will not exceed 2,400*l.*) should not have been built on the fire-proof principle. It seems doubtful policy to run the risk of total destruction, if a fire should occur, for the sake of saving 200*l.* or so, in original outlay;—as the warehouse is now built (with wooden trussed beams, joists and boards), if a fire took place the whole would, ten chances to one, be destroyed; if built fire-proof, the chances are that one storey only would be burnt.

A large warehouse, of four storeys besides the cellar, has been built for Mr. Carver, in Portland-street, from designs by Mr. Donnison. It is of brick, with stone basement, doorways, window sills, and cornice, and is of plain and substantial construction. The same Architect has another large warehouse in progress for Mr. Behrens, of five storeys and cellar. The first storey is externally of tooled stonework, and has coupled pilasters between the windows, and a dentelled cornice runs below the second floor windows. A stone cornice resting on corbels surmounts the whole.

Messrs. R. H. Greg and Co. are having a warehouse built in Tib-street, from designs by Mr. Whittaker, and Messrs. Taylor and Williams are the builders. The basement is externally of vermiculated stonework. The first storey is of good tooled ashlar, with a dentelled cornice. The upper part of the warehouse will be of best brick with handsome stone quoins, and all the windows will have moulded stone architraves. It is intended to place an elaborate stone cornice at the top. The whole is fireproof and of good strength, and I understand that the cost cannot be less than 8,000*l.*

Mr. Lane, the Architect, is at the present time employed in entirely remodelling the old "Queen's Theatre," in Spring Gardens, and from what I can learn of the alterations it seems likely that a most convenient and beautiful interior will be the result. The walls of the building have been underset, the stage and pit lowered five or six feet below the original level, the pit extended under the boxes, and the stage enlarged. It is intended to erect a new proscenium, and to alter the whole decorative character of the house. Mr. Bellhouse's workmen are now busily proceeding with the alterations, and it is intended that all shall be ready for an opening in March next.

Schools.

The MANCHESTER COMMERCIAL SCHOOLS are now nearly finished, and are to be opened in January next. They have been built under the auspices of the Church Education Society, from the designs of Messrs. Holden, Architects, on a plot of ground in the Stretford New Road. The building is three storeys high, and in the Tudor style of architecture. The front is of stone, and the first story has two entrance doorways, with three windows between them, the centre one a triplet, and the others double windows, with flat or four-centred arches; the second story has an oriel window with enriched panneling above and below, and two smaller windows with hood mouldings on each side of it; the upper storey has a large window in the centre, with a depressed four-centred arch, and rich tracery in the head, and two smaller windows with hood mouldings on each side. The ground floor contains the assistant-master's offices, porter's residence, &c., and also a covered play-ground, about 42 feet by 30 feet, communicating with a spacious play-yard. The second floor is set apart as four class-rooms, a large hall, and a book and model room. The whole of the upper floor will be occupied as the general school room, 55 feet by 42 feet, and as the roof is open to the rafters the room is an airy one. In these schools a good church and commercial education will be afforded to the youth of the middle classes upon reasonable terms.

The Roby Day and Sunday Schools, for children of the independent denomination, situate in Aytoun-street, were built a short time ago from designs by Mr. A. W. Mills, Architect. The building is in the Elizabethan style, and of best brick and stone. Considerable skill is displayed in the arrangement for supporting the building so as not to interfere with the burial ground over which it is erected; the front wall goes down to good brick foundations, but the back part is carried on iron pillars and beams. There are three gates into the yard through the lower part of the front wall, and also other smaller arches which are filled in with ornamental iron-work. Above are three projecting oriel windows of two storeys; the front is surmounted by ornamental gables. The internal arrangements are spacious and well ventilated.

Roman Catholic Church, Salford.

The largest ecclesiastical building in the neighbourhood of Manchester at this time in progress, is the edifice being built by the Romanists in Chapel-street, Salford, from designs by Messrs. Hadfield and Weightman, of Sheffield. The general plan is cruciform, with a central tower and lofty spire. The cardinal points have not been regarded in the placing of the building, as the chancel is towards the north. On the south side of the tower projects the nave, which is divided into four bays, and has a lofty clerestory. The principal entrance doorway is at the end of the nave. On the north side are the choir and chancel, which are now intended to be carried out about the same length as the nave. The original design showed it projecting only one bay beyond the tower, but a school-house has been taken down to allow of the extension. The transeptal chapel is on the western side of the tower, and will be lighted by a large wheel window; there will be an entrance to the chapel from the outside, and the vestry adjoins it. The transept on the east of the tower has a central entrance doorway. The roof of the choir will be groined in wood, and that of the nave framed in square panels, and painted in light colours by Bulmer. Sticklers for orthodoxy and correct imitation will discover little to cavil at in the details of the work, such as tracery of windows, arch mouldings, &c.; they are generally copied from Howden church, Yorkshire, or from contemporaneous structures; indeed the principle of imitation seems to have been carried too exactly throughout, for the most elaborate mouldings of that exquisitely delicate period of architecture the early decorated, are given in places where a simplification of them would have produced an adequate effect; if this be an error, however, it is on the right side. Newark furnishes a model for the spire, Howden for the nave, and Selby for the chancel; indeed the last will be a counterpart of its prototype, even to the canopied niches over the columns.

The Irish Presbyterians are now erecting a place of worship, session-house, schools, &c., in New Bridge-street, Strangeways, from designs which are highly creditable to the architects, Messrs. Travis and Mangnall. The style selected is the Gothic, which prevailed in England during the reign of Henry VI. There will be a tower 80 feet in height, next to the street, which will be flanked by bold diagonal buttresses; these will diminish in size towards the top, and will finish at the battlements with crocketted pinnacles above. The central entrance doorway will have bold moulded jambs, and a label finishing upon carved heads; above this doorway will be a large window with perpendicular tracery and moulded jambs and labels; similar windows will be situated at each side of the tower on the front face of the building, and in the back will be a four-light perpendicular window. There will be two side entrances near the tower end, having square-headed doorways with labels, &c. The sides of the building will be divided by massive buttresses into five bays each, and the windows between them will be enriched with tracery and labels terminating on grotesque heads and shields, and will have a transom in the middle on account of their height. The roof will be open-timbered, and in one span of 47 feet. At the back of the chapel are buildings to be used as session-house, schools, and residence for the minister, the whole of which are built in the style of the domestic buildings of the period.

Mansions.

A mansion in the Italian style for Mr. Percival, situated near Kersal Moor, from designs by Messrs. Dickson and Brakespeare, is in a forward state. There are two good specimens of gentlemen's residences nearly ready for occupation in Victoria Park; one for Mr. Critchley, designed by

Mr. Walters, in the Italian style, the walling being of rough pierrepoints with tooled stone dressings: and the other for Mr. James Bellhouse, in the Tudor style, having the fronts of tooled stone, and the back of rough pierrepoints.

Mr. Bowman is the architect for a house lately commenced in the same park for Mr. Langworthy.

A residence is also in course of erection for Mr. Wilson Crewdson, at Moss-side; it is being built from designs by Messrs. Holden, and is externally constructed of stone; the style of architecture is the Domestic Tudor.

The residences we have mentioned are in good taste, but there are many houses in the suburbs which are in the style which will be known by the title of "Gingerbread Gothic," which style appears to have professors in every locality. I am glad to observe, that in and about Manchester, the use of stone is becoming more general; the "Yorkshire pierrepoint" rough dressed on the face, and in courses of five or six inches, is the kind most in demand at this time, which, although more expensive than brickwork, is not so much so, but that the effect obtained fully compensates for additional outlay. The yellow firebrick is occasionally used for dwelling houses, and the effect is very good.

LIVERPOOL.

St. George's Hall.

In Liverpool, that magnificent pile of buildings, St. George's Hall, is assuming an imposing appearance, and already justifies the high expectations which have been entertained with respect to it, and all who view the structure must agree that the Architect, Mr. H. Lonsdale Elmes, has produced a noble design, and that the superiority of the workmanship in each department proves that he has been ably seconded by the contractors, Mr. Tomkinson and Messrs. S. and J. Holmes.

I had prepared a description of the plan and different elevations of the building, but on referring to vol. vi. p. 329 of your journal, I find excellent drawings and a well written account of the whole; I therefore proceed to notice only the present state of the work.

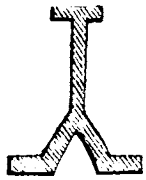
The exterior of the building is now in a very forward state, the parts most behind being the row of columns on the east front, and the covering in of the large hall.

The north end of the building (that having a semicircular projection) is completed; and when I visited the place the workmen were engaged in laying the top stones of the south portico. The great hall is 169 feet long, and 75 feet wide, and is intended to be covered by a semicircular arch, springing from the side walls. The height from the floor to the top of the arch will be 87 feet. Around the large hall in the interior will run an ornamental moulded plinth, with 24 projecting pedestals, similar in character, and 24 columns upon them: the plinth, pedestals, and columns are of highly polished Scotch granite. Some of the columns are in their places, and are as beautiful specimens of workmanship and materials as it has ever been my lot to examine; they are each 31 feet long, and average 3 feet in diameter.

The columns and the die of the pedestals are of red granite, from Peterhead near Aberdeen, and the plinth and impost of the pedestals of grey granite, from the same neighbourhood. The whole of the parts have been worked and polished at Aberdeen, and when put together in their places, the joints are perfectly true and good. The mechanical arrangements for the removal and working of the large blocks of stone required in this building are admirable, especially the powerful and lofty derricks with steam engine and boiler complete, working along the lines of railway laid parallel to the main walls of building; and also the various railways with travelling cranes over the stone yards.

Docks.

The Albert Dock and warehouses now being built by the Liverpool Corporation, under the able superintendance of Mr. Jesse Hartley, the Dock engineer, are nearly finished; the dock, with all the entrance gates, &c., is complete, and several of the immense piles of warehouses are in a condition to receive goods. These erections are exceedingly strong, and built throughout on the fireproof principle. The iron beams are somewhat different in form of section to those generally used, inasmuch as they have inverted V grooves running along the underside of the beam, so as to divide the web near the bottom into two parts, and forming a good abutment for the brick arches to be built against thus:—



The beams are also slightly curved longitudinally. The columns and beams are of massive proportions; indeed the whole of the work is strong and of good design.

The well-holes for the purpose of hoisting the goods up are large, and surrounded with strong iron curbs, and enclosed by wrought iron doors. All the window frames are of cast iron, and the entrance doors of wrought iron plates strongly put together. The roofs are framed in iron, with a covering in some cases of sheet iron, and in others of zinc. Some of the floors are covered with tiles, others with planed flags, others with asphalte, &c.; indeed there seems to have been a disposition to give each kind of roofing and flooring a fair and impartial trial. This is as it should be, as these experiments can best be made by a public body; it is to be hoped that the results of a due trial of the different kinds of material, as regards cost and duration, may be published for the benefit of those engaged in building similar works, in the Journal.

The approaches from the town to St. George's Hall, and the railway station, have recently been considerably improved by the widening of Lime-street, Charlotte-street, and Ranelagh street. Rows of shops are being built; and a Register Office is nearly completed in Lime-street, from designs by Mr. Clayton, Architect. The building is fronted with tooled stonework, and consists of three lofty storeys. The first floor has circular-headed windows, splayed from the outside, with plain moulds round them. The upper windows are square headed with moulded jambs and caps. A plain cornice runs alone above the first floor windows, and at the top of the front elevation is a stone cornice with scroll corbels. The safe is spacious and of good construction; the floor, side walls, and arched top, are of fire-brick, and the arches are built upon strong iron beams, and skewbacks connected by tie rods. A set of double iron doors, with Chubb's locks, are strongly fixed in the safe doorway.

BIRKENHEAD.

At Birkenhead, on the opposite side of the Mersey to Liverpool, we have the strange spectacle of a noble city springing, as if by magic, into existence; numerous spacious streets and squares have been layed out, sewered, paved, and lighted with gas, and rows of splendid shops and comfortable habitations are being erected with unexampled rapidity; whilst the surrounding neighbourhood is becoming diversified by picturesque mansions and villas, which are intended for the residence of the wealthy.

The new Docks at Birkenhead are speedily progressing, and a visitor cannot but admire the manner in which the natural advantages of the locality have been made available. The site of the docks was formerly Wallasey Pool, a large area which was entirely sand bank at low water, but covered by the tide at high water. The Woodside Pier has been considerably widened and improved, and will form one side of a tidal basin of 16 acres in area. Between this basin and Seacombe will be two spaces of quay 60 acres each, between which will be a large low water basin of 37 acres, forming the main entrance to the Great Floating Dock, which when complete will have an area of 150 acres, and be 19 feet in depth. There will also be a small dock near the entrance. The land adjoining the basins and docks, and the reclaimed land, will be used for quays, yards, &c., and will be built upon with warehouses, depots, offices, and other necessary erections. Mr. Tomkinson has undertaken the contract for the whole of the dockwalls, &c.; and the energy with which the work is being executed is highly creditable. Several steam engines have been put down which are working mortar mills, and hoisting the materials from the bottom of excavations to the top of the quays; two limekilns are in full operation; and a range of workshops and smithies are occupied by artizans busy preparing the ironwork requisite for the railways, cranes, &c., about the works. The cost of the dock walls and gates is expected to be about 400,000*l*.

Birkenhead Park.

The Commissioners of Birkenhead have set apart a space of 190 acres as a park; 60 acres to be appropriated to detached villas and grounds, and 130 acres devoted for the use of the public for ever. Mr. Paxton has made the most of a very flat and unlikely piece of ground, and laid out the whole in an admirable manner, and the trees and shrubs appear in a healthy condition. Two lakes with rustic bridge and boat house are well situated, and add to the interest of the scene. There will be six fine lodges or gate-houses, three of which are now completed; Messrs. Walkers, builders, have contracted to complete two grand entrance lodges of stone, for the sum of 3,642*l*. It is said that the total cost of the enclosures, lodges, and laying out of the park, will amount to 20,000*l*.

New Market.

The New Market is now open for the use of the public, and is a great attraction, as it combines every modern improvement. The building is 430 feet long, and 181 feet broad, and is divided into three avenues by two rows of iron columns, which support a light iron roof in three spans. A handsome fountain is situated in the centre of the building, and a row of elegant gas pillars run along each of the three avenues.

Light is admitted from two rows of semicircular windows at the sides, as well as from skylights in the roof. The whole is cellared below, and the floor is arched on iron beams supported by columns. Messrs. Fox, Henderson and Co., of Birmingham, were the contractors.

Four new churches are being provided by the munificence of private individuals. I had not opportunity of learnnig particulars about them, but from what I saw they appear to promise well.

In concluding this sketch of what is doing in architecture and building in the localities I have had opportunities of visiting, it may be well to state that, generally speaking, the works in progress are decided improvements, as regards taste in architecture, skill in construction, and quality of materials used, upon previous works of a similar character in those localities.

There appears less disposition to substitute the sham for the real, and it seems as though people were at length becoming more generally acquainted with the fact, that it is in reality little more expensive to erect buildings which shall be ornamented and not offend good taste, than it is to provide those which have no pretension to design.

December 12th, 1845. A. B.

THE COLOSSEUM IN THE REGENT'S PARK.

There is a Colosseum at Rome, and another at London, but their likeness extends no further than their names, for hardly can any two things similarly denominated less resemble each other; the first being one of the most stupendous monuments of antiquity,—a truly colossal fabric, which, though deeply scarred by time, or rather by the hand of man, still bears the look of being eternal; while the other is merely a thing to day—a toy in comparison with the latter—an architectural butterfly as contrasted with an architectural *megatherium.* The Flavian Amphitheatre or Roman *Coliseo*—for such is the Italian orthography of the name—is a work to be classed only with the pyramids and some of the gigantic temples of Egypt; such an enormous mass, that it would seem to have required not merely a few years but a century to quarry the stone and put the materials together. It is to ancient Rome what St. Peter's is to the modern city, the "sovran" pile among countless others, the leviathan structure that engages attention, whatever else be passed unheeded; the object of universal admiration, be the admiration genuine, or, as no doubt it frequently is, merely affected and acted for fashion's sake. The Roman Colosseum has been a theme for poetry, both in verse and prose: sublime in itself, it is also arrayed in the halo of antiquity, and an imposing one it is, for it is apt to play tricks with and delude the imagination. Whereas our modern Colosseum is the very antithesis to all this: to the antiquarian it is a mere nullity: if he looks at it, it is only to turn up his nose at it with a contemptuous sneer; with him its very name crushes it into insignificance, by calling up more forcibly the image of the other to his mind. Still, there is something—nay, very much—to reconcile us to the disparity between the two buildings—to the disparity of their purposes, if nothing else. The arena of the ancient one was drenched with human gore. "There man was slaughtered by his fellow-man," to gratify the passion of a brutalized population, for spectacles of carange and bloodshed. Humanity will rather exult than sigh over the proud ruins of the Colosseum, though it must at the same time blush with indignation for the race who could coolly look upon the cold-blooded and wholesale murder of wretches, "butchered to make a Roman holiday," and call it *amusement!*

Most happy is it for us that the exhibitions at our modern Colosseum are of a far different character from the savage pomps and proudly atrocious spectacles of the ancient and right imperial one. This consideration may more than console us for the inferiority of our own edifice in comparison with the one after which it is named—or rather *misnamed,* because, leaving the vast difference as to size, between the two, out of the question, they bear as little of architectural resemblance and analogy to each other as they do of similarity of purpose; whereas the modern structure does really bear a strong likeness to another ancient Roman edifice that is of no less celebrity than the Colosseum itself. But the title of "Pantheon" had been preoccupied by the building in Oxford-street, which, even now that it is completely altered from its original shape, still retains a name that though in some points applicable when first bestowed, has now become a complete misnomer. Therefore, as ancient Rome possessed no more, one Pantheon was considered quite enough for modern London, vast as it is; accordingly the building in the Regent's Park was dubbed the Colosseum, for even the veriest Cockneys would have been scandalized at the absurdity, had it been named after the great pyramid. Of the exterior of the main building we may be allowed to say a word, because it is of considerable merit as a piece of architecture,—better worth than many that have obtained an infinitely greater share of notice from critics, and which, notwithstanding that they are now quite eclipsed by later productions of the art, still retain the rank first assigned them, owing to the character given of them being scrupulously transmitted from one book to another. The portico of the Colosseum is by very far the noblest specimen of one in the Grecian Doric style that we possess in London, one upon a nobler scale than any other, before the magnificent portico of the new Royal Exchange was erected, the columns full as lofty, (40 feet,) and of course of much greater diameter, those of the Exchange being Corinthian, consequently of slenderer proportions. The situation, indeed, takes off somewhat from the effect of size, for did the building stand in a street or other confined space, we should be more impressed by its magnitude of. It possesses, however, one very decided advantage over almost every other of our attempts at pure classicality of style, inasmuch as nothing is mixed up with the portico itself to disturb the antique physiognomy aimed at by that feature; there are no modern windows peeping out between the columns, or showing themselves elsewhere;—none of that intermixture of *columniation* and *fenestration* which is so contrary to correct Grecian architectural idiom.

Except that it has been renovated, the exterior of the building remains in *statu quo,* but the interior has been, if not absolutely remodelled in plan, metamorphosed into something altogether different in character,—transformed into one of the most captivating and fascinating pieces of internal architectural scenery that can well be imagined. The exquisitely tasteful rotunda or circular colonnaded saloon, into which it is now converted, stands almost unparalleled for both beauty of design, and felicitous originality of idea. If there be anywhere aught comparable to or resembling it, our acquaintance with matters of the kind does not extend to it. Although rooms far more sumptuous may be found, enriched with treasures of art, and set off to all possible advantage by the costliest furniture, we know not of one that is so charming for intrinsic beauty of design. Neither any of our royal palaces, nor of our most palatial club rooms, the Reform and Conservative not excepted, can show an apartment that is at once so novel and so impressive, so fraught with loveliness and witchery, as in this saloon or gallery of the Colosseum. Loveliness is the epithet that best describes it, since striking as the coup d'œil on first entering it may be, whether in the day time, or when lit up of an evening, the effect is not so much that of showy splendour, and dazzling brilliancy, as of mild and serene elegance, and of that tasteful simplicity which satisfies the eye, every part being complete and in perfect keeping, nothing superfluous and nothing deficient. In order to convey to our readers something like a positive idea of this truly charming interior, we may begin by describing it as a circular hall, completely surrounded by a peristyle of twenty Grecian Ionic columns, which divide the entire circumference into the same number of inter-columns or compartments; within, and corresponding with which, are as many recesses, the two compartments excepted, one on the west and the other on the east side, which serve as entrances. The columns are of scagliola, or to be more exact, of Keene's cement, in imitation of polished white marble; and the mouldings of their bases and capitals being gilt, produces a peculiar delicacy of enrichment, in which the monotony of uniform white, and the spottiness occasioned by scattered masses of gilding, are equally avoided. The entablature corresponds with the columns, with this difference, however, that the frieze being enriched with basrelief, (copied from the Elgin marbles,) the figures are raised upon a ground of a blue grey tint. The attic over the entabulature is ornamented with twenty oblong panels, containing allegorical subjects painted in fresco; and the ceiling or roof is divided into the same number of compartments by as many ribs, between which the light is admitted, the compartments being entirely glazed, yet not after the manner of a skylight, but so as to produce the appearance of a transparent roof, since it consists of *tesseræ* of cut-glass set in reticulated framing; consequently the light is somewhat refracted, and the raw look of a room almost uncovered and open to the sky, is avoided.

Thus far, description has been easy to ourselves, and, we trust, sufficiently intelligible to our readers, but without some drawing of it, it becomes difficult to explain that peculiarity which renders this rotunda so unique in plan, and so widely different in character from every other interior of the same class. Instead of the whole space that is surrounded by the colonnade being entirely open, so as to be fully exposed to view from every part, and be completely covered by a dome, the centre of the rotunda is occupied by a mass of cylindrical form, whose diameter may be about a third of that of the larger circle. Thus the rotunda assumes quite a different character from what is usually understood by that term, it being converted into a spacious '*ring* gallery' enclosing and running round another portion of the structure. Now, there is such a general prejudice in favour of having as much open and uninterrupted space as possible, that most persons may be apt to consider it a pity that the structure was not planned as a simple rotunda or single circular hall. Those who affect connoisseurship may even go further and say that we have here only the noble idea of the Pantheon spolled by the excrescence in the middle of it, obstructing a perfect view of the colonnade in its entire expanse and circumference. Happily, however, or else unhappily for ourselves, we do not hold with such narrow and one-sided criticism which, instead of estimating things according to what they are, depreciate them very summarily for not being what they are not designed to be. The same flower cannot be both a lily and a rose, nor can the same fruit give us the flavour of both the peach and the pine-apple. But for a circumstance which we shall presently explain, we might have had a copy of the interior of the Pantheon—nay, one that might in some respects have been rendered an improvement upon the original; yet, though that would have been positively and exceedingly good in itself, we should not thereby have acquired something altogether new in character, and which, if they are able or care to profit by it, opens quite a fresh train of ideas to architects for hitherto untried and unadopted combinations of plan. Had the striking peculiarity of plan in this structure been chosen solely for its own sake and that of the effect attending it, we should even then have been disposed to welcome so graceful a *caprice;* instead of which, it was a matter, not of choice, but actual necessity—a most fortunate necessity—compelling the architect to deviate from all precedents, whether he would or no, it being indispensable to obtain a staircase in the centre of the building, leading up to the platform gallery, from which the panorama is viewed. That staircase is accordingly concealed within the upright cylindrical mass, or tower-like shaft, that forms what may be called the *core* of the entire structure; and this staircase encloses within itself, and winds round another shaft, which is also hollow, and which is turned most admirably to account. Within it is a small octagon room, or cabinet, capable of containing seven or eight persons, and fitted up in a fanciful yet tasteful manner, having, among other decorations, a transparent ceiling of coloured glass, through which it is lit up by means of a gas-burner fixed over it. You enter this very fairy-looking closet, seat yourself on one of the velvet-cushioned benches, and before you have finished examining its embellishments, the door opens, and you find yourself at the top of the building—that is, on the platform of the panorama—without having been sensible of any motion during your ascent. Here then, we have not only a quite novel idea and most ingenious contrivance, but one that may occasionally prove essentially serviceable. Most assuredly Catherine II. would have liberally rewarded the inventor of such an enchanted flying cabinet; for when she began to grow infirm, and found it too fatiguing to go up and down a staircase, her architect was ordered to construct one that should be less toilsome of ascent, but he could hit upon no better expedient than that of substituting a series of inclined planes, or slopes, for steps, which, besides being not very satisfactory in itself, was attended with the inconvenience of rendering the distance to be walked over very much greater; whereas an ascending chamber, like the one at the Colosseum, would have spared Her Imperial Majesty the trouble of walking, or even standing. There are also others besides empresses who would be glad to be spared the trouble of going up a great number of stairs. To ascend, for instance, to the top of the Monument, toiling up a frightfully narrow, dark, and winding staircase, is not only a laborious task, but a somewhat formidable exploit: an ascending closet, or even mere platform, within the shaft of the column, instead of stairs, would have obviated all difficulty and danger—though, we ought to observe, it would have required a different mode of construction for the shaft itself, as there would have been neither newel nor steps within it, which now serve to hold it together. But there are far more probable and frequent occasions where the same mechanism might be employed: a single visit to the top of the Monument, or other structure of that kind, is sufficient for the curiosity of most persons; but, if it is to answer its purpose, a lofty prospect tower, or *belvedere*, whether in the grounds of a mansion or attached to the mansion itself, ought to be as easy of access as possible, or it will very rarely be made use of; whereas it would be most pleasant and convenient to be able to step at any time into a handsome little closet adjoining your sitting-room, and a minute or two afterwards step out again into another room in the upper story of a lofty belvedere tower, where, secure from intrusion, you might, like the tower-loving Beckford, enjoy both the wide expanse of surrounding landscape and literary study, merely glancing your eye from the book in your hand, or the well-stored portfolio on the table before you, to the prospect stretched out below and around. But halt! or our readers will fancy that we ourselves have ascended into an altitude, and taken a flight very far away from our proper subject; so we will descend as expeditiously as we can, without so much as stopping to speak of the "Panorama of London," which part of the Colosseum remains in *statu quo*—that is, in the day-time, for in the evening it produces quite a different effect, it being then transformed into a veritable bright moonlight night. However it be managed—and of course there must be a good deal of artifice besides the painting itself—this view is the triumph and perfection of scenic skill, for the full moon actually shines out from the picture, shedding its radiant light upon the platform and the spectators themselves; its beams flicker upon the surface of the Thames, while the mighty labyrinth of streets presents a flaming network of gas-lights gradually dying away into the far distant horizon. Happy magic! that can create for us brilliant moonlight on any or every night in the year, in the despite of the almanac. Bidding adieu to the upper region of the Colosseum and its moonshine, we again enter the Rotunda, and find it quite as charming as at first; nor must we hurry through it, for though we have already reconnoitered it, there is more to be said concerning it,—very much more, in fact, than can even be touched upon in an article like the present. One thing which we have not yet told our readers is, that which is now denominated the *Glyptotheca* (or Repository of Sculpture), in consequence of its being made to serve as an exhibition room, for casts of statues and groups by many of our principal modern English sculptors, including one or two by Thorwaldsen, and other foreign artists; all of them disposed in the most tasteful manner between the columns and within the recess, so that the mere arrangement of them becomes in itself a picture; the architecture and sculpture mutually set off each other to advantage, and both together, thus harmoniously combined, render this Glyptotheca the most admirable sculpture gallery in the world. It would be absolute folly to pretend to compare it with many others either for its magnitude, or for the value and excellence of the works of art which it contains; what we mean is, that taken in its ensemble and as an architectural picture, it has no rival, if only because there is nothing at all similar to it. The sculpture galleries at the British Museum are very little more than very large yet blank-looking rooms, that would be quite empty were it not for the sculpture itself; and many other places of the kind also, look very little better than so many statuaries' warehouses, or show-rooms, when their works are exhibited for sale. As to the sculpture room at the Royal Academy, that is so utterly unfit for its purpose, so wretchedly confined, and contemptibly mean, as to be little if at all better than a mere lumber-room, into which things sent to be *exhibited*, are stowed away during the exhibition. Yet that dismal "black hole," as it has been called, belongs to an academical body rejoicing in the ear-tickling epithet "Royal," where the delicious Glyptotheca,—and "delicious" is the epithet it truly deserves—together with all the rest of the Colosseum, is merely a private speculation, of course with a view to ultimate profit, which it richly deserves, but entered upon in a most liberal spirit, and carried through with admirable ability. It is moreover no less striking an instance of sound economy than of liberality, the best of all economy being to do well what is worth doing at all; although it is a species of it, which very few seem to understand; for how frequently do we observe some little paltriness suffered to peep out amidst splendour, some mark of penny-saving niggardliness to betray itself amidst extravagance, some jarring deformity to obtrude itself amidst beauty.

Runcorn.—Stupendous Bridge.—We have been favoured with a view of the plans of the Grand Junction Extension Railway from Aston-grange to Huyton, and also with those for the bridge in connexion therewith, to cross the river Mersey at Runcorn. Our readers may form idea of its magnitude when we state that there are to be five wet arches of 280 feet span, 100 feet above high water mark at spring tides, and 168 dry arches of 30 feet span, and 51 feet high, making a total of 2,480 yards of arching, which will be, when completed, the greatest work of the kind in Europe. This great architectural design will be a boon to the counties of Chester, Lancaster, and Stafford, giving the required facility to the Potteries and to the fertile mines of Cheshire. We predict that the rising port of Runcorn is destined to become a great emporium of commerce; and Lord Francis Egerton, with a desire to meet the coming exigency, is about to erect docks of great extent on the shore of the Mersey; and will also apply, at the next session of Parliament, for a trunk railway; thus affording the port a ready transit for goods, in addition to the two canals in his lordship's possession. We are credibly informed that it is the intention of Lord Francis Egerton to erect a new Custom-house, the present edifice, now in use for the Customs, being found most inconvenient for the growing trade of this thriving port. We congratulate the officers who are immediately concerned, and the trade generally, upon this wise and judicious measure, and are much pleased to find that his Lordship intends to act with so much liberality.

ARCHITECTURAL SYNOPSIS OF SOME OF THE PRINCIPAL BUILDINGS IN EDINBURGH.

Buildings.	Date.	Architect.	Remarks.
Academy, New Edinburgh ..	..	W. Burn	Said by Britton to be "illustrated by a beautiful portico."
Advocates' Library ..	..	W. H. Playfair	New Room, 140 x 42 x 28, recesses with Corinthian colonnades along sides, central compartment with low dome and skylight.
Assembly Rooms	1787		Plain Roman Doric on basement—tetrastyle portico (added 1818). Ball-room 92 x 42 x 40.
Assembly Hall	1844	J. Gillespie Graham	Gothic, with spire.
Bank of Scotland	..	R. Crichton	Corinthian on rusticated basement. The south front very much in Adam's style—petty and pretty.
„ Royal	..	Sir W. Chambers	Originally the mansion of Sir Lawrence Dundas. Tetrastyle Corinthian pilasters, on basement, and crowned by a pediment.
„ Commercial	1845	D. Rhind	On site of Physician's Hall. Portico Corinthian, hexastyle in antes.
Bridge, North	1765-9	W. Mylne	Connecting High-street with Princes-street. Three arches 72 feet span; entire length 310 feet.
Chapel, Catholic	1813	Gillespie	Gothic. Internally 110 x 57.
„ St. George's	1794	R. Adam	An octagon structure in Pseudo-Gothic style.
„ St. John's	1816-18	W. Burn	Gothic of feeble character.
„ St. Paul's	1816-18	A. Elliot	Gothic, perpendicular style, internally 105 x 63.
„ Dr. Jamieson's	1819-20	Gillespie	
Church, St. Andrew's	..		Portico, Corinthian, tetrastyle, monoprostyle. Body of church an ellipsis.
„ St. George's	1811-14	R. Reid	Ionic loggia; dome 60 feet diameter externally 140 high from ground to summit; style poor.
„ St. Giles's	..		Nearly consumed by fire, 1844. A heavy and patched-up Gothic mass.
„ St. Stephen's	about 1826	W. H. Playfair	Plain Doric, on a basement story; square tower of two stories at one angle.
County Hall	1816-19	A. Elliot	East front, tetrastyle Grec. Ionic portico.
Exchange	1754-61		Irregular in style, partly Corinthian.
Heriot's Schools	1845	Alex. Black	
High School	1825	T. Hamilton	The happiest and most picturesque application of Grecian style in Edinburgh. Centre portico hexastyle, lateral colonnades of seven intercolumns, and end pavilions with four antæ-pilasters in front.
Hospital, Donaldson's	1842, &c.	W. H. Playfair	Elizabethan style. Building 269 x 275 feet. Internal quadrangle 176 x 164.
Holyrood Palace	..	Sir W. Bruce	The quadrangle and chief part of the actual buildings by Sir W. Bruce.
Hospital, Heriot's	1628-50	Inigo Jones?	Style later Elizabethan, but rather poor, yet the building interesting as an architectural monument.
„ Merchant Maidens' ..	1816	W. Burn	Grec. Ionic, tetrastyle portico; in other respects of quite ordinary design.
„ Watson's	..	W. Burn	Doric, hexastyle, monoprostyle portico, ditto, ditto.
„ Gillespie's	1801	W. Burn	A mixture of castellated, Tudor, and 'sash-window' styles.
„ Lunatic Asylum ..	1810	R. Reid	Not completed.
Monument, Melville	1821-2	W. Burn	A fluted Doric column, 136 feet high, including pedestal (18 feet).
„ National	1822	Cockerell?	Intended to have been externally a copy of the Parthenon, but was discontinued after a few of the columns had been erected.
„ Nelson	..		A lofty circular tower of five stories—style intended for castellated.
„ Playfair	..	W. H. Playfair	This cenotaph a square mass formed by four Grec. Doric columns on each side, on a lofty solid stylobate.
„ Scott	1840-5	G. M. Kemp	A Gothic *Cross*, with pinnacles.
„ The Martyrs ..	1844	T. Hamilton	Egyptian Obelisk.
Observatory	1818	W. H. Playfair	A low Grec. Doric structure, with dome and hexastyle portico on each of four fronts.
Parliament House	..	R. Adam?	The building towards Parliament-square, a rather handsome elevation in the best Adam style, but disfigured by the second floor windows having no dressings.
Physicians' Hall, Old	1775-7	J. Craig	Tetrastyle Corinthian portico. Now taken down.
„ New ..	1845	Thomas Hamilton	Tetrastyle porch with statues over the end columns, and a *distyle* over the two centre columns.
Post Office	..		Plain Grec. Ionic, on a basement floor.
Register Office	1774	R. Adam	Considered one of his best works.
Royal Institution	1825	W. H. Playfair	Grecian Doric, portico double octastyle, recessed colonnades alone sides.
Regent's Bridge	1815-19	A. Elliot	Carried over Carlton-street in continuation of Waterloo-place, on an arch or tunnel 40 feet wide, 55 high, and 80 in depth. The parapet adorned on each side with a small colonnade, and an open arch and Corinthian columns in the centre.
University or College	1789, &c.	R. Adam	The largest pile of building in the city—about 400 x 250 feet. Handsome, but not sufficiently dignified; the original design, as then intended, published in Adam's works.
St. Bernard's Well, Leith Water ..	1790		A handsome small open circular temple or monopteros, of Doric order, on stylobate and basement; but now in a very ruinous condition.
Debtors' Prison	1845	T. Brown	Carlton Hill.

GREAT BRITAIN STEAM SHIP.

(With an Engraving Plate I.)

It is with great satisfaction that we commence the series of plates illustrating this volume with a subject of so general and valuable interest to engineers, as the engines of the "Great Britain." Plate I. is a copper-plate engraving representing the position and general arrangements of the engines. The vessel is supposed to be cut a-midships; so that one half the machinery is shown; two of the four cylinders, half the drum whicq drives the endless cogged chain, &c. A full description of the Great Britain was given in the last October and November numbers of this Journal, which it is not necessary here to report, as the engraving is not sufficiently explanatory of itself. It has been carefully reduced from the original drawings of the Great Britain, which were courteously placed at our disposal of the purpose: the scale of the plate is a quarter of an inch to the foot.

EXPERIMENTS ON STEAM.

A paper by M. Regnault was read at the Paris Academy of Sciences, on Dec. 15, relative to his experiments on steam. The Minister of Public Works assisted M. Regnault with the means of making these experiments on an extensive and practical scale. The questions to be determined by M. Regnault were—1. The law which unites the temperatures and elastic powers of aqueous vapour at saturation. 2. The quantity of heat absorbed by a kilogramme of water at 0 degree, to be converted into steam for saturation at different degrees of pressure. 3. The quantity of heat absorbed by the same quantity of water, in order to raise the temperature to the point in which it assumes the state of vapour under different pressures. 4. The specific heat of aqueous vapour at different stages of density, and at different degrees of temperature. 5. The co-efficients of dilatation of aqueous vapour in different stages of density. In his present paper M. Regnault gives the law of the elastic powers of steam up to 23 degrees centigrade, which temperature corresponds to 28 atmospheres and a half. He next fixes the total heat of steam taken at different pressures, from 1-5th to 15 atmospheres; and finally, he treats of the calorific capacity of water from 0 to 190 degrees. Many distinguished men have devoted their attention to the elastic powers of steam. We may mention Achard, Greu, Dalton, Christian, Arzberger, Watt, Robinson, Betancourt, Schmidt, Southern, Ure, Gay-Lussac, August, Kaemtz, Dulong, and Arago, the two latter of whom commenced their experiments in 1823, at the request of the Minister of the Interior, and published an account of them in 1829. They carried their operations up to 25 atmospheres. About the same period a commission of scientific Americans performed a series of experiments on this subject, but went up to only 10 atmospheres. The results, however, of these different experiments were not alike, consequently M. Regnault had to take entirely new ground, greatly aided, however, by the progress which science has made since the period alluded to. In his results he agrees most with MM. Dulong and Arago, particularly as regards high rates of pressure. Watt had supposed that the total quantity of heat necessary for the transformation of a kilogramme of water into the state of steam was certain under a constant pressure. The number admitted was 650. This law, although not exemplified by any precise experiment, had been, until very lately, regarded as positive, and so adopted in theory and practice. M. Regnault, however, has ascertained that this number increases constantly from 622 under the pressure of one-fifth of an atmosphere up to 670 under 15 atmospheres. At the ordinary pressure the average of 38 experiments gives 636·37. As to the calorific capacity of water, it is 1,000 between 0 and 30 degrees, 1,005 between 30 and 120, 1,013 between 120 and 190.

THE CATHEDRAL OF ST. DENIS.—The monument erected to the memory of Louis XVIII. in the vaults of the Cathedral of St. Denis is about being completed, and, when finished, that of Charles X., his successor, will be proceeded with. When this is done, all the French Kings and Princes up to 1830 will be there represented either by a tomb, a monument, or a statue.

CHRIST CHURCH, PLYMOUTH.

We have received some information respecting the architecture of this church, which has recently been completed, from the designs of Mr. Wightwick. The dimensions are about 70 feet by 90 feet. The style, Perpendicular. The western front presents three entrances and three gable roofs, of which the central or highest gable reaches the height of 50 feet. Between it and each of the wing gables rises an octagonal turret, and at the outer sides of the wing gables are pinnacles.

It will be concluded from this description of the western front, that the interior of the church is divided into three compartments—of these the central one, or nave, is divided from the lateral aisle by piers. There are five arches on either side of the nave, and over them clerestory windows, which give the principal light; for owing to the contiguity of neighbouring buildings, there are no windows whatever in the side aisles, and consequently there is no means of lighting the church except by these clerestories and the windows at the east and west ends.

Our informant says it was absolutely necessary to introduce galleries. However, it appears that the galleries are set so far back, as not to abut on the piers, and as they do not cross the aisle windows (there being none to be crossed,) this "absolute necessity" is not so much to be regretted as it otherwise would have been.

The architect has shown great judgment in the selection of some of his details, from ancient examples. The western entrances are copied from those of Tattersall Church, the crockets and finials of the octagonal turrets from those which many of our readers may remember at Magdalene College, Oxford.

The nature of our information does not warrant a very decided criticism on the merits of the new church—the general character of the architectural details is probably unexceptionable. Unless, however, we be greatly mistaken, the building has one great fault—a *show front;* the elevation towards the street exhibiting considerable pretensions, while the other sides of the church are merely plain masonry. If misinformed on this point, we shall be glad to be set right. If, however, the fact be as here assumed, it certainly will materially diminish the architectural value of the building. One of the most admirable characteristics of the old Christian architects was their total freedom from pretence. They never adorned one side of a church and left the other three sides plain—taking care to turn the *dressy* side where it would be most seen. There is no ancient cathedral, minster, abbey, church, or chapel in Christendom with a show side. The old architects never attempted to cheat beholders into a belief that their works were elaborate, when in truth they did not deserve the character. Of course these remarks must not be considered to imply a censure on the architecture of the Plymouth Church. The architect cannot of course be blamed for the defect alluded to, if he had no power of remedying it. Still it is greatly to be regretted that he should have had to exert his talents under circumstances which would of necessity produce an unsatisfactory result. At the east end of the Church, in the place where the chancel is usually built, is a "communion recess," ten feet deep.

Since the above was in type, we have received a description of the church, taken from the Plymouth Journal. As however this description is very similar to that given above, we avail ourselves of the following part only of the extract sent to us. "The interior presents an effect of lightness and elegance which is admitted by all who have seen it, and fully justifies the architect in his idea, that the details of Gothic architecture may be employed in the fullest consistency with that expression of *openness* which should characterize a Protestant church. In fact the public of these towns have now an opportunity of making a fair comparison between the peculiar characteristic of the *Camdenite* structure, and those of the Reformed Church. St. Michael's, at Stoke, and Christ Church, at Plymouth, are now before them. In the former, we have the picturesque—in the latter, the elegant. The first shows a handsome, though unfinished exterior; the latter its single front of far more ornate character, the means of the architect being concentrated on one point, and that being brought to perfect completion. St. Michael's is of the most simple plainness within, and affects no more than a general expression of shadowed gloom. Christ Church exhibits, within, the decorative amount promised without, and unites solemnity with grace. Though 'cheerful as the day,' it is not less, as Cowper would say, the house of 'true piety.' What the cost of St. Michael's may be, we have yet to learn; but we know, that Christ Church has been completed, including 85*l.* for extras, for only 6*l.* 8*s.* 6*d.* above the architect's estimate—the total cost of the building being 3,475*l.* The accommodation is for 1120 sitters, of whom 35 may, hereafter, have to make way for an organ. The clear internal dimensions of the church are, from east to west, 87 feet, and from north to south 68 feet."

ON THE CHANGE OF OSCILLATORY INTO ROTATORY MOTION.

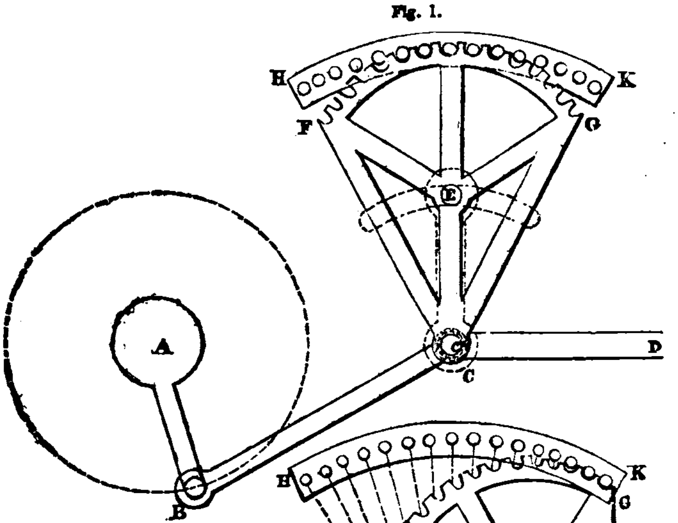
By F. Bashforth, B.A., Fellow of St. John's College, Cambridge.

Notwithstanding all the disputes respecting the crank, it appears that no better substitute has been or probably can be found. In fact, the beautiful adaptation of the velocity of the end of the connecting rod to the requirements of the piston is such as cannot be surpassed. Still there appears to be a great objection to the present method of employing it in locomotives and some of the steamers, as the Great Britain. The piston rod and the connecting rod are inclined at a considerable angle during the most important part of the stroke, and this gives rise to very considerable friction.

In the beam engine, and where there is room for its application, the parallel motion of Watt has been found to answer completely every purpose, but in locomotives, &c. there is not the necessary space. For this purpose it is proposed to make use of the well-know property, that if a circle of radius r roll in the interior of a circle $2\ r$, any point in the circumference of the former will constantly describe the same diameter of the latter. This geometrical principle has been already applied in mechanics, but never, it is believed, in the manner about to be explained.

In figs. 1 and 2, H K represents an arc of a circle, having equal cylin-

Fig. 1.



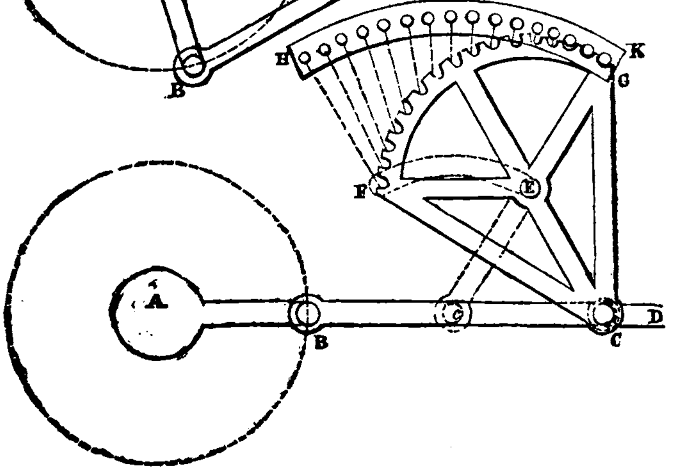
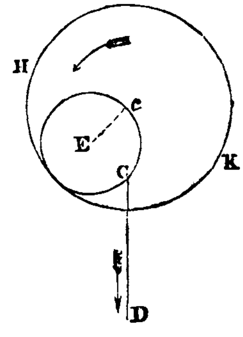


Fig. 2.

drical studs fixed at equal distances in the pitch circle of radius $2\ r$, c being its centre. These are fixed firmly to the frame. The bar c E, represented by the dotted line, is capable of moving about the fixed centre c, and at E carries the centre of the segment F G of radius r; c E $= r$ C D is the piston rod, and during its oscillations C F is compelled to roll on H K, and C will describe a perfectly straight line. The pivot E had better be rigidly connected with the arm c F. The figures represent a projection on a plane perpendicular to the axis, which is turned by the crank. The diameter of K H must not be less than the length of the stroke of the piston. The figures represent the necessary sines of the several parts to ensure a stroke C B, the whole of the guarding machinery being on one side of the piston rod.

Figs. 3 and 4 represent two differnet states of the same contrivance for



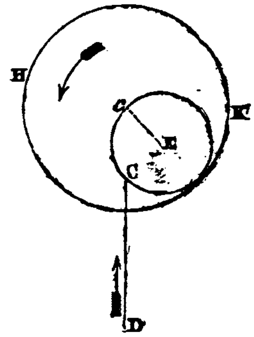


Fig. 3. Fig. 4.

communicating motion directly to the crank, without the employment of any connecting rod, and so that the axis to be turned may be placed at little more than half the length of the stroke from the end of the piston. The letters refer to the same parts as before, the pitch circles alone being represented.

In this arrangement the cranks must be at the end of the axis to be turned. This, however, would not be of great importance in its application to the screw propeller, or to locomotives, where the connecting rod acts outside the wheels. It is evident, from an inspection of the figure, that the velocity of C is greatest when passing c, and that it is gradually brought to rest at each end of the stroke, although c E may be revolving all the time.

In order, however, to render these suggestions of any practical utility, it will be necessary to point out the method of rendering the motion extremely easy and durable. The studs should be made sufficiently strong to withstand the forces to be applied, and covered by short triblet-drawn brass tubes, and left at liberty to revolve. These could easily be changed in a short time, if they should become bruised or worn, and would save from injury the constant parts of the machinery.

It is well known, that by the geometric chuck almost perfect epicycloids and hypocycloids can be traced with ease and rapidity. Now, hese are the curves required wherever pin wheels are used. Suppose that we have a large chuck, and that we replace the tracing point by a circular drill or cutter kept constantly revolving with its centre in the place of the point, as the chuck, on which the wheel to be cut is mounted, is caused to move slowly, the exact form of the teeth will be given. The teeth ought to be cast sufficiently large to bear shaping by the revolving tool. On account of the certainty with which almost perfect forms can be given to the teeth of such wheels by ordinary workmen, it appears that this method of changing angular velocity would be useful where strength and freedom of motion are required, whether for turret clocks, or for increasing the angular velocity of the screw propeller.

The methods of forming the teeth of spur wheels in common use appea to be very defective. There are so many chances of error in the setting out and cutting of patterns, and afterwards in the alteration caused by unequal construction of metals, that it appears desirable that some improvement should be made; and I am in hopes of being able to point out a method by which teeth of any pitch may be formed without any change of cutter, and approximating very nearly to the forms recommended by Professor Willis.

THE RAILWAY SUSPENSION BRIDGE.

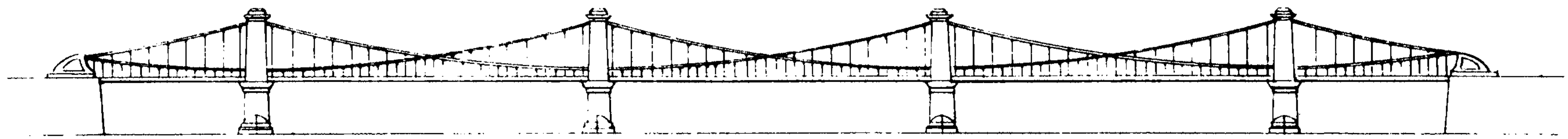
Patented by Mr. H. H. Russell.

(*With an Engraving, Plate* II.)

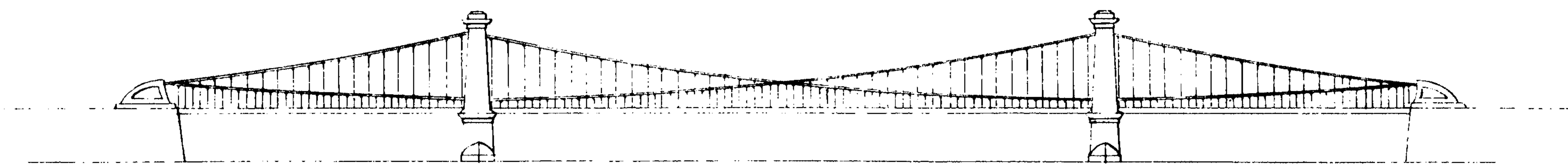
The accompanying illustrations (Plate II.) exhibit the construction of a recently patented suspension bridge, which the inventors propose to apply to the purposes of railway traffic. We have been favoured by Mr. Lapidge, the county surveyor for Surrey, at whose expense the patent was secured,* with a description of this invention, written with a mo-

* A model of the bridge, upon a large scale, may be seen at Mr. Lapidge's offices, Derby-street, Westminster.

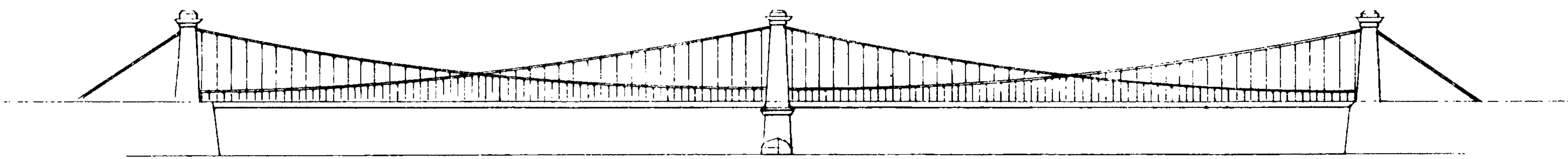
PATENT RAILWAY SUSPENSION BRIDGES.



Bridge applicable to a Site where a Line of continuous Arches to any extent are required.



Bridge applicable to a Site where a Centre and Two Half-arches are required.



Bridge applicable to a Single Span of 400 Feet or less width.

deration all the more praiseworthy because it forms a nearly unique contrast to the extravagant encomiums which inventors usually bestow on their own productions. As, however, on consideration, we think we can discern advantages in the present invention which are not quite apparent at first sight, and which are not commented on in the description which we have received, we have ventured to give our own version. The inventor will have no cause to complain of the determination.

It is not, however, to be understood that on a subject so complicated as the theory of suspension bridges, any judgment, however carefully considered, can have the same value as one pronounced in simpler cases. The general problem of the equilibrium of suspended chains is so difficult when applied to practice, that it is impossible to predict with certainty the exact practical effect of any untried arrangement. However, as in the present instance, the inventors do not apply themselves to the complicated questions respecting the relation of the various tensions to the strength of material, but confine their attention to the means of preventing *oscillations* and *undulations* of the platform, the subject can be satisfactorily examined without the use of mathematics.

The leading idea of the invention is so simple, that a very few words will suffice to explain it. Each chain of the ordinary suspension bridge is replaced by two lighter chains *crossing each other*. Each of these crossing chains is suspended by its *highest* and *lowest* points, and the two may also be fastened at their points of intersection. The suspending rods are fastened to each chain alternately, and the edge of the platform will be therefore supported, throughout its length by a series of alternately long and short rods.

Every practical engineer knows the importance of strengthening a structure by supports or ties arranged cross-wise. The roofs of railway stations may be referred to as familiar instances of the value of cross ties. Wooden bridges, in which the beams are arranged diagonally, and cast iron girders, with cross ribs, are examples of the same principle. In fact it may be laid down as a general principle that all structures where the points of support are at considerable distances from each other, derive stability and rigidity from a system of oblique rods or beams.

Let us now see how this principle applies to the case before us. The disturbances to which a suspension bridge is liable, from external forces, are of two kinds—first, oscillation, or swinging of the chain from side to side—secondly, undulation, or the vertical rising and falling of the several parts of the platform. Now, with respect to this first kind of disturbances it is obvious that a chain suspended from the tops of two piers must be more *pendulous* than one fastened by its highest and lowest point. That a catenary suspended by its two highest points is readily set in motion, and can be maintained in motion by a slight force, may be readily seen from the familiar instance of a child's swing. But it may also be seen from the same instance, that if the lowest point of the curve be *fastened*, the liability to oscillation is almost entirely removed. In the invention before us, this method of preventing oscillation is adopted, and the advantage is further increased by the union of the two cross chains at their points of intersection.

The second kind of disturbances of suspension bridges—the undulatory—is by far the most important. The height of the undulations of the Menai bridge in a storm has been known to be some 8 or 10 feet, while the transverse oscillations were scarcely observable. By far the most important part, therefore, of the invention of intersecting suspension chains is the means they afford of preventing the rising and falling of the platform. This effect is, however, not immediately obvious, and we shall perhaps have some little difficulty in rendering the explanation of it intelligible.

What we wish to show is this—that the effect of two chains, both united to the platform, is such that, where the deflection of the one chain would tend to raise the platform, the other chain would tend to depress it—so that the two chains would, during the passing of a load, counteract the tendency of each to elevate or depress the several parts of the roadway.

To make the point clear we will refer to the figure of the single-span bridge in the accompanying plate. We will suppose that a heavy carriage has got some distance across the bridge, but has not yet reached the centre of it. Now let us see what is the effect of this load on each chain *separately*—first, for instance, on the chain which at this place is the highest. The load rests on the platform, and tends to sink it, and this tendency is communicated by one of the long rods to the upper chain. If, however, the action of the rod pull down the chain at this point, we know by the nature of suspended chains, that the whole of the curve will be acted upon, rising at some points and sinking at others. Now let us see what the effect of the passing load is on that chain which at the place in question is lowest. Here the effect of the load is transmitted by one of the short rods, which tends to depress this chain also; and here again, if the chain be actually depressed, the whole curve will be acted upon, rising at some points and sinking at others. But if the matter be attentively considered, it will be found that *the parts of the one chain which tend to rise are directly above those parts of the other chain which tend to sink*, so that these tendencies are opposite to each other, and are counteracted by the attachment of both chains to the platform.

Or, to express the same thing another way, a passing load tends to alter the whole curvature of both chains—to draw the two chains, in some places, closer together, and, in others, wider apart, than they are in their positions of equilibrium. In the ordinary single-chain suspension bridges there is nothing but the weight of the chain and platform to resist this tendency to alter the forms of the curves; but in this double-chain bridge the alteration is resisted by the tensions or thrusts of the connecting rods.

If we have succeeded in making this point clear, the reader will see that these counteractions occur, not at one or two points of the bridge, but at every point of it. Everywhere therefore there will be a tendency to bring the two chains closer together, or move them wider apart, and these effects are everywhere prevented by the connexion of the vertical rods, each of the rods exerting either a tension or thrust to resist the effect of the passing load. The two curves cannot either recede from or approach each other on account of the rods, so that the case is altogether different from that of the ordinary suspension bridge; for there a passing load acts only on the suspending rods immediately adjacent to it—but here every vertical rod of the whole bridge is acted upon by the load, and resists its tendency to depress the platform.

The effect therefore seems to be to convert the whole structure into a system almost perfectly rigid, to give it, without any additional weight of iron, nearly the stiffness and stability of a girder. This is by far the most important part of the invention, and deserves the careful consideration of the engineer.

It is a point worth noting, that the vertical rods would not always be in a state of tension as in other suspension bridges, but occasionally would have to resist compression also, (where the load tended to bring parts of the two curves closer together), and therefore these rods would have to be made with more than the usual rigidity.

Of course on so complicated a subject as that of suspension bridges, no opinion on practical points is perfectly trustworthy till verified by experience. We cannot determine exactly to what extent rigidity might be attained in a suspension bridge on this new principle, still we think enough has been said to show that the rigidity would certainly be far greater than what can be obtained in the common suspension bridges, without additional stiffening by strong diagonal ties. These greatly increase the weight of the structure, and are generally inapplicable from the difficulty of finding convenient points for attaching them.

REVIEWS.

Companion to the Almanac, or Year Book of Information for the year of our Lord 1846. London: Charles Knight, 12mo., pp. 260.

This is the nineteenth of a series of annual volumes published under the superintendence of the Society for the Diffusion of Useful Knowledge. The information in this volume is collected under two heads—first, "mathematics, natural history and philosophy, chronology, geography, statistics," &c.—secondly, "the legislation, statistics, public improvements, and chronicle of 1845." The first chapter is on the "earliest printed almanacks," and treats very fully of the history and successive improvements of the calendar. This paper is written by Prof. De Morgan; it contains, however, no display of his mathematical genius, but exhibits a vast amount of antiquarian erudition. We have chosen one or two short extracts, as well for the curious nature of the information they afford, as to give a general idea of the style of the paper. Speaking of the difficulties which the Church experienced in determining the time of Easter, and reviewing the various remedies proposed for these difficulties, it is observed—

"Regiomontanus is the next after Bacon who declared that the *usus ecclesiæ* was not in accordance with the *decreta patrum;* he does not attempt the usual historical falsehood of fixing the existing method upon Eusebius and the other Nicene bishops, but refers it (and truly, as we showed in our last number) to the Abbot Dionysius, "whose pascal calender," says he, "we are using to this day." He mentions the diffusion of the Scriptures among the people in their native tongues as giving rise to many doubts and questions upon the subject; and alludes to this diffusion as having taken place in Italy, and specifically as having caused a reference to Cardinal Bessarion when he was legate at Venice. He further says that the Jews very frequently raised objections to the existing Christian mode of determining a feast which was asserted to be connected with the Passover; and so far had the dissatisfaction gone, that some priests of Bremen* (*sacerdotes premenses*) had undertaken to correct the error themselves, and had kept Easter a month before all the rest of the Church—for doing which the adjective *premenses* had become a standing joke against them with a double meaning.

Between clocks and watches, lighted roads, and public announcements, we are now so well provided with information, that an almanac is not a matter of the first necessity to most persons. It was otherwise in the fifteenth century; and if we consider how much comfort must have depended upon being able to arrange business with reference to the numerous holidays and the moonlight, we shall see that the mere list of saints' days and moons must have been a matter of consequence."

The topic of astrology is naturally touched upon as pertinent to the subject in hand.

"There are many manuscript almanacs of the fifteenth century yet remaining. They may be divided into what we now call *astrological* (a word which was then frequently used in its original sense), and those which were simply astronomical. The majority of the astronomers in the middle ages believed in the prognosticating power of the stars: even Roger Bacon inclines to the supposition that they have a physical influence on the body, and through it on the acts of the mind. The Church of Rome always, collectively, set itself against this absurdity. Not that its popes and cardinals were by any means universally free from belief in it; but those who believed considered it as magic, while those who disbelieved thought it of course an organized fraud. So that, upon the whole, divination by the stars met with little public encouragement, and its professors were obliged to write about it under modified phrases. We have never found, in ancient astrologers, such impudent pretensions as those which have been published in London in our own day. If the members of the Stationers' Company, who still continue to publish an astrological almanac, could see this trash, and could know that there are shops in London which sell nothing else, and that there are persons who make a trade of imposing on the ignorant, and who doubtless quote their authority, we suppose they would not allow any consideration of profit to induce them to lend their names to the continuance of so vile an imposition. We should recommend them never again to do what they have done in *Moore's Almanac* for the present year, namely, insinuate that unbelief in astrology is infidelity, and denial of the providence of God. This is an oversight, arising from an unskilful attempt at imitation of the old almanacs; it must show the Stationers' Company that if they will play with edge tools, and call it sport, they ought to be very careful how they use them."

The note referred to in the above extract is as follows:—

"We quote our ground for this charge from Moore's Almanack for 1845. The italics, when mixed with Roman, are our own."

'Astrological Predictions. *Judicium Astrologicum, pro anno* 1845. *Vox Cœlorum, Vox Dei: The Voice of the Heavens is the Voice of God. He speaketh in all the Changes of the Seasons and of the Times.*—Courteous Reader,—In this my annual production, I have a long time sounded the *above important truth* in your ears, and I trust *not in vain*. It is, *however*, to be lamented that there is a *great deal of infidelity* upon the face of the earth, and even no small portion thereof cleaves to the skirts of Britannia. .... That wonder-working Hand, which placed each mighty orb.... is clearly manifest in our earth by the changes of seasons..... Let those who are disposed to *deny the existence of Divine Providence* reflect on these words of holy writ, Not a sparrow falleth.....'—Such an innuendo would have been too bad for the sixteenth century."

The following extract is taken from a foot note, p. 17.

"Those who observe that Boyle has let Melancthon off for his astrology with two words and a reference, would hardly imagine the lamentable extent to which this weakness was his master. On his death-bed, he half predicted that he should die on the day on which a conjunction of Mars and Saturn would take place: and on one occasion, being seen bathed in tears, and showing every sign of the greatest grief, it was found on inquiry that on looking at the stars in his evening's walk, he saw that a dreadful war was going to burst upon Germany. The first story is from his most accredited biographer, Melch. Adam; the second from a less respectable source, the "Jocorum atque Seriorum Centuriæ" of Otho Melander, whose grandfather, Dion. Melander, was the person who asked Melancthon what was the matter with him. This same Otho relates a severe rebuke which Melancthon received from Luther, for saying that persons born when Libra was in the ascendant must be miserable through life: and a ridiculous attempt to cast the nativity of an infant child of his (Otho's) grandfather, whom he supposed to be of the male sex, and to whom he promised learning, honours, and religious contests. Being told that the child was a girl, he was out of countenance for a time, and at last said—then she will rule her husband. But on second thoughts he cast a new scheme, in which he condemned her to death at seven years old, and staked the validity of his art upon the prediction. The girl lived, however, till the age of fourteen. Otho was of the reformed church, and was therefore free from one bias against Melancthon, at least."

* At least Bremen is called Premis and Premen in contemporary cosmographies: but it may be that these priests were of Parma, and that Parmenses was altered into Premenses for the joke's sake.

The paper of Prof. de Morgan is followed by a very useful article on foreign exchanges, and some elaborate tables of the fluctuations of the funds. We should have liked to have made some extracts from the tables of the "statistics of crime," as the subject is intimately connected with one for which we have frequently endeavoured to enlist the attention of our readers—the sanatory conditions of large towns. We must, however, for lack of space, pass on to a subject more immediately connected with the objects of this work, "the railways of Great Britain." Under this head there is a brief abstract of all the railway acts passed during last session—forming a synopsis somewhat similar to that which appears in our present number, excepting that no notice is taken of the amalgamations and other private arrangements of companies. The following extract is likely to be read with interest, as giving a good compendium of parliamentary proceedings respecting railways during the past year.

"On the 31st of December the Railway Department of the Board of Trade issued the first of a series of reports upon the schemes thus examined by them, in which reports, after enumerating all the projected lines in a certain district, they expressed their intention to report to parliament in favour of certain schemes and against some others, while they recommended the postponement to a future period of such as they considered might be modified to advantage, or might be rendered unnecessary by the introduction of better or more comprehensive schemes. The more detailed reports in which they explained the reasons which had influenced their selection, were not, in most cases, published until some weeks after the announcement of their decision. In selecting from a mass of rival, or partially rival, projects, the Board usually gave their recommendation in favour of the new lines projected in friendly connection with, rather than those in opposition to or competition with, already existing lines; and in cases where the engineering features of two or more rival schemes were essentially different, they entered, in their detailed reports, at considerable length into such questions as the comparative merits of the locomotive and atmospheric systems of propulsion, of different systems of gradients, of width of gauge, and other peculiarities of construction. In consequence of an idea that such reports would decide the fate of railway bills, some projects which had been prepared for parliament were withdrawn in deference to the recommendations of the Board of Trade; but in many instances the promoters determined to proceed with their bills in the face of adverse reports, a course which appears to have been by no means disapproved by parliament, since many such schemes were successful in obtaining their acts, while some of those most warmly supported by the Board of Trade were defeated in Committee upon their merits, and others, in consequence of informalities (resulting, in some cases, from the impossibility of preparing the requisite parliamentary plans and sections by the appointed day, or of submitting them to the searching examination necessary for the detection and correction of clerical errors, when the demand for surveyors, levellers, draftsmen, and engravers was so urgent as in the autumn of 1844), were thrown out for non-compliance with Standing Orders. It being very evident that, whether the Railway Officers of the Board of Trade had or had not exceeded the powers committed to them, their recommendations were distasteful to the Select Committee of the House of Commons, upon whose right of decision they appeared to trench, the Railway Department has been completely remodelled by a minute of the Lords of the Committee of Privy Council for Trade, dated the 10th of July, 1845, by which the distinct Board constituted by the minute of the 6th of August, 1844, was discontinued, and it was determined that in future all railroad business should be transacted by the Lords of the Committee of Privy Council for Trade in the same manner as the ordinary business of that Committee.

In the House of Commons, the enormous amount of railway business formed the most remarkable feature of the session, and such of the Standing Orders as relate to the composition of the Committees on private bills were suspended, so far as railway bills were concerned, it being impossible, under such extraordinary circumstances, to adhere strictly to the usual practices of the House. Railway bills were, at the commencement of the session, divided by a "Classification Committee" into *groups*, each of which was referred to one Select Committee, who were allowed to sit during any adjournment of the House, in order to get through the immense mass of business before them. Notwithstanding every exertion, many competing schemes failed, from want of time, to obtain a hearing; and some bills which were virtually passed, were necessarily left over to next session, a special arrangement having been made to allow the privilege of re-introducing in 1846, and carrying on from the point where the proceedings left off in 1845, such bills as had been ordered by the House of Commons to be ingrossed. Before the close of the session some alterations were made in the Standing Orders, by which the additional maps and statements required by the minute of the Board of Trade above quoted, are required to be deposited, and the amount of deposit required before presenting a petition for a railway bill is again increased to *ten*, instead of, as in the last session, *five* per cent. of the amount subscribed. This increased deposit, however, is not required in the case of bills which have been before parliament in 1845, and may be re-introduced in 1846, or of undertakings provisionally registered before it was issued, or such as had their subscription contract executed, or partly executed, on the 29th of July, 1845. Among the important parliamentary proceedings of the session we may refer to the passing of the Railway Clauses' Consolidation Act, by which all future railway acts will be much simplified; and the appointment, in consequence of a motion in the House of Commons by Mr. Cobden, of a Royal Commission "for inquiring whether, in future Private Acts of Parliament for the construction of railways, provision ought to be made for securing a uniform gauge, and whether it would be expedient and practicable to take measures to bring the railways already constructed, or in progress of construction, in Great Britain, into uniformity of gauge: and to inquire whether any other mode of obviating or mitigating the serious impediments to the internal traffic of the country, which are represented as likely to arise from the want of a uniform gauge, could not be adopted."

We regret we cannot find space for more than a brief enumeration of the greater part of the remaining subjects of information. There are some very valuable tables comparing rates of life insurance in different companies, abstracts of public acts of parliament, and parliamentary documents, a chronicle of the sessions, and a numerical account of petitions and private bills. The information throughout these chapters is arranged in a very careful and satisfactory manner.

The thirteenth chapter treats of "Public Improvements," and is divided into three sections headed respectively, "General Improvements," "Churches," and "Miscellaneous Buildings." Of this part of the work we regret to say that we cannot speak in the same terms of commendation as of the rest. Whether it be that the conductors have here towards the end of the volume been compelled to put their remarks together in a more hasty manner than in the preceding parts, we cannot tell; but the diction is careless and very frequently ungrammatical, and many sentences require to be read several times before the meaning of them can be ascertained. Of these faults however we should not complain, (as we do not here profess to write a literary criticism) were the language sufficiently perspicuous to explain the views of the authors. This however is by no means invariably the case, and even when we succeed in finding out what ideas on architectural subjects are intended, we are seldom recompensed for the labour of discovery.

The first piece of criticism is on the architecture of the new buildings behind the Royal Exchange. Unfortunately enough these buildings are praised for the qualification which they least of all possess. Speaking of the arrangement of the windows, it is observed that it "is such as not to cut up the mass itself into littleness, as is too generally the case owing to *the windows being put too closely together*, which inevitably occasions an ordinary dwelling-house look to prevail." Now without offering any opinion of our own on the merits of the building in question we may state, as a simple fact, that the ground floor of the building exhibits one continual series of arched window-openings, separated only by piers. In many of the conservatories which are attached to large country seats, and are built to assimilate in architecture to the contiguous buildings, the aggregate surface of the windows is not so great compared with that of the masonry, as it is in the ground floor of the buildings behind the Royal Exchange. The observation that "this arcade is exceedingly well proportioned as to the quantity of window opening as compared with the entire surface," was written, it may be suspected, *before* the writer saw the building.*

The next subject of commentary is Trafalgar Square. Of this it is said, "The two fountains seem to have altogether disappointed the public; for not only have they been ridiculed by those who make mere ridicule pass for criticism, but have been spoken of seriously by those who profess to deal in sober criticism as things of 'intense ugliness,' which *is rather too severe, since the insignificance of their appearance is at least an equal defect*." This passage, of course, contains a reference to the criticism of the Trafalgar-Square fountains, which appeared some time since in the *Civil Engineer and Architects' Journal*: the objection now raised to that criticism is odd enough. First, insignificance of appearance is spoken of as something distinct and separable from ugliness; secondly, the former of these qualities, though it is said to be an "equal defect" with the latter, is assigned—not as an additional reason for its condemnation—but on an altogether new system of logic, as a proof that our criticism was "rather too severe"!—"which is rather too severe, *since* the insignificancy of their appearance is at least an *equal defect*"!

Another "defect" is discovered in the architecture of Trafalgar Square, which certainly never suggested itself to ourselves. The writer, whose knowledge of the English language is as profound as his knowledge of architecture, says that "a singularly disagreeable effect" is produced, because "the tops of the wall are not made to rise and fall like hedges." We confess that this plan of making Trafalgar-Square "agreeable" never occurred to us. An excuse for all the defects noticed, is, however, found in the consideration that the site was a very bad one! "Barry certainly here undertook a very ungrateful task, it being hardly possible to make anything satisfactory out of such an ill-arranged spot." We always imagined that the principal cause of the public disappointment respecting Trafalgar Square, was, that "one of the noblest sites in Europe" was sacrificed in an abortive attempt at architectural display.

In commending the new buildings in Lincoln's Inn, it is observed that the ceilings, "though only of deal *unpainted*, have the appearance of being of a superior kind of wood, great depth of hue and lustre being imparted to it by some novel process or preparation." The word "unpainted" is marked in italics, to intimate, we presume, that the imitation is excused from censure, because it is not produced by paint—that the weight of the censure depends not on the simple fact of deception, but the method of effecting it. This principle is that of the Spartans who used to punish their children for larcenies—when they committed them clumsily.

Had the writers on "public improvements" been accustomed to be present at the hall-dinners at Lincoln's Inn, they might frequently have heard the merits of the ceilings in question dismissed somewhat unceremoniously by the appellation—"Brummagem." The criticism, to be sure, is not that of professed architects, but it is at least that of gentlemen and men of educated taste.

In noticing buildings deserving of admiration, there is a particularly unfortunate tendency to choose for commendation the very particulars which a judicious friend might have passed over in silence. The above is a striking instance, but there are many others. In the Colosseum, the first subject of commendation is the circumstance, "that the columns, &c., are of white marble—or, at least, have all the appearance of being so," being formed of a composition "that imitates that material *most deceptively*." The new church at Leeds is said to exhibit a "most praiseworthy regard to *permanent* excellence," the last quality we should assign to a Gothic Church with plaister ceilings.

The final chapters of the work are a "Bankruptcy Analysis," and a "Necrological Table of Literary Men and Artists." The volume, though not absolutely free from grave faults, may, on the whole, be pronounced a valuable and certainly cheap repository of the information usually contained in a "Year-book."

Ancient and Modern Architecture; consisting of Views, Plans, Elevations, Sections, and Details of the most Remarkable Edifices in the World. Edited by M. Jules Gailhabaud. Series the second. Parts 35, 42. London: Firmin Didot, 1845, quarto.

We have already noticed some of the previous numbers of this series of engravings; those before us embrace almost every kind of architecture, as may be seen from the following list of the principal subjects:—Church of St. Zachary, at Venice; Theotocos Church, at Constantinople; St. Etienne du Mont, Paris; Flavian Amphitheatre, Rome; the beautiful temples of Vesta at Tivoli; Celtic Monuments, &c. The engravings are executed in a very satisfactory manner, a due regard to pictorial effect being observed, without a sacrifice of the accuracy of the architectural details. The letter-press, however, occupies by far too small a portion of the work, which, owing to this defect, has too much the character of a picture-book for a work on ancient and modern architecture. The archæological notices are, however, carefully selected, and are verified, for the most part, by formidable arrays of authorities. We have selected the following extract, to give some idea of this part of the work. It is a description of the Church of the Theotocos (mother of God) at Constantinople, a very important specimen of a style not very well known in this country—the Byzantine:—

"The plan lies east and west, the surface of the soil sloping from the apsis to the façade, so as to require a double flight of steps to reach the principal entrance; two porches, with columns opening towards the west, admit the the light to a spacious vestibule, which is extended round the corner, along

* By these observations we do not intend the slightest censure of the actual arrangement of the windows, which is perfectly unobjectionable, considering the purpose and site of the buildings; we state the simple facts of the case to shew the ridiculous and ignorant absurdity of the criticism. From a rough admeasurement which we have made, we are quite certain that the space for glass occupies upwards of two-thirds of the ground frontage—which is, in fact, no more than a continued series of glazed arcades!

the lateral faces of the church—an arrangement precisely similar to that adopted in the church of St. Mark at Venice. In the interior, this vestibule, or narthex, is decorated with a number of marble columns, which, from the general form of their shafts, and the sculpture of their capitals, seem to have been obtained from some ancient edifice..... A second narthex, or vestibule, surrounded on three sides by the one we have just described, communicates immediately with the aisles of the church, from which it is separated by a thick wall, with three large doorways in it. This second vestibule receives its light from the outer one by two arcades, and communicates with it by a large door on the axis of the edifice. According to the general usage among the Greek Christians, the three aisles of the church are traced in a space exactly square, with four thick columns arranged symmetrically in the centre, to support the roofs and the principal dome—a disposition resembling the Corinthian *atrium* of the ancients. The nave, much wider than the side aisles, has two massive pillars at the end, which divide it from the sanctuary, the first part of which is square, but it terminates towards the east in a semicircular apsis, with three windows separated by small columns attached in piers. On each side of the sanctuary is a door leading into the sacristies, which are at the end of the side aisles.....The façade of the Theotocos is very regular; the floor of the narthex is raised to the level of the church by a basement. The principal entrance is approached by two flights of steps, under which there is a circular brick arch. The arched doorway projects a little, and above it there is another arch divided into two parts, and open, to give light to the vestibule. The sides of the façade are each divided into two zones; the bottom ones are occupied by three arcades, separated by short marble columns, whose capitals and bases, of the same material (see fig. 3, pl. 3), have all the peculiar characteristics of the Byzantine style. The arches are turned with stone and bricks alternately. Tablets of white marble, ornamented with crosses and crowns, are placed between the columns, and support narrow jambs, that reach as high as the capitals, and appear to have supported lattice casements, or perhaps glazed windows, to protect the narthex. Towards the corners of the facade, beyond the open porches, there is, on each side, a semicircular niche of very elongated proportions. The wall is composed of courses of stone and bricks of equal thickness. Between the arches over the columns, the builder has introduced lozenge-shaped bricks, separated by horizontal lines; near the two niches which occupy the extremities of the facade, the bricks are turned in arches concentric with those of the niches.....Above the whole rises the central cupola of the church. This cupola stands on a square basement, and consists of twelve small columns, supporting arches under which are the same number of windows, to light the dome. The spherical portion of the cupola is covered with sheet lead, and in the centre there is a very graceful little ornament. East and west of the cupola we see the roofs of the church, of the interior narthex, and the sanctuary. This last is lighted from above by a window in the vaulted roof.....The apsis stands on a polygonal stylobate of five equal sides. In the upper part there is the same number of arcades, two of which are closed, and three open; these last, which give light to the sanctuary, and are probably intended, as in the church of St. Sophia, to be an emblem of the Trinity, are supported by columns inserted in square piers, and are repeated inside in exactly the same form and size. Their bases, composed of a fillet and a torus, stand upon a stone that forms a common plinth, and is of a pyramidal shape. Their capitals have a kind of ornament composed of numerous bevilled mouldings, in the Byzantine style; a thin ledge, which projects considerably outside, supports the ribs formed by the junction of the polygonal faces of the apsis. In the square pillars against which the columns are backed, there are a number of holes, from which it is evident that these windows have been closed by iron gratings. Above these arcades there is a row of arched niches, which have been exactly copied in the cathedral of St. Mark, at Venice. The back of the vaulted part is ornamented with brick zigzags. The roof of the apsis is a demi-cupola, covered with lead, and hipped, to correspond with the five sides of the vertical portion. On each side of the apsis are the constructions that form the eastern end of the side aisles and vestries; in the centre of each there is a polygonal apsis, not projecting, but merely cut in the thickness of the walls."

It would have been better to have devoted a larger portion of the work to pure, and less to bastard, architecture. What possible architectural value, for instance, can there *now* be in the church of St. Etienne, at Paris, a lamentable instance of the sacrifice of a fine mediæval edifice to the pseudo-classic mania? It were hard to find another Christian church in which the original features have been so completely effaced by hideous imitations of Roman details. The barbarous mutilations of the church of St. Etienne exceed even those of the west front of Westminster Abbey.

Railway Almanac, Directory, Year-Book of Statistics and Digest of Railway Law for 1846. London: Groombridge, 8vo., pp. 182.

We are somewhat late in our notice of this work; still, as almanacs are seldom purchased till the beginning of the year, our recommendation will appear about the right time. In addition to the ordinary information, the *Calendar* contains the dates when the existing railways were opened, the periods when the dividends of each company are payable, &c. The *Railway Law Digest* (written by Mr. Shaw, of Furnival's Inn) is the most perspicuous explanation of a very difficult subject which we have met with. We have read it through carefully, and can pronounce it well worthy of the labour of perusal. The *Directory* contains the names of the directors and officers of all the completed and projected railways; it gives also the lists of the members of the Stock-Exchange of London, and the chief commercial towns. The work is very well printed, and in the arrangement of it great care has evidently been taken to secure facility of reference.

Jabez Hare's Illustrated Engineers' Almanac for 1846. Simpkin and Marshall.

This is a large sheet Almanac. In addition to the calendar, it contains wood engravings of several mechanical inventions, such as the railway excavator, the steam hammer, and screw propellers, of which also brief letter-press descriptions are given. There are also tables of areas of circles, of specific gravities, and the pitch of toothed wheels, &c. Mr. Hare evidently far exceeds Lord Chesterfield in his admiration of proverbs: the Almanac is garnished by a double belt of them.

First Steps to Anatomy. By J. L. Drummond, M.D., Professor of Anatomy and Physiology in the Royal Belfast Institution. London: Van Voorst, 1845. 12mo. pp. 210. 12 lithograph plates.

It would be somewhat travelling out of the record to give a critical notice of this book, even if we laid claim to the editorial omniscience which alone would warrant us in undertaking the task. The work is a digest of lectures to the "first-year students" in the Royal Belfast Institution, and is written in a very pleasing and perspicuous style.

NEW MODELS OF THE PARTHENON

In the British Museum.

The trustees of the British Museum have recently made a most valuable addition to the collection of antiquities of two large models of the Parthenon, made by Mr. Lucas, the sculptor. We are unavoidably compelled to postpone till next month a critical description of these admirable works of art; the following notice of them, however, which is extracted from the Athenæum, will be read with interest.

Mr. Lucas, the sculptor—of whom we have heretofore had occasion to make honourable mention,—has been for some time engaged on a work, which, while it is at once very interesting in itself and honourable to the artist who planned and performed it, comes usefully as a sculpture-lesson in this time of awakened attention and improving prospects for the Art. His object has been to achieve two models of that most perfect of temples, the Parthenon—one of which shall represent it as it appeared in its dilapidated state in the seventeenth century, and its other being, in the sculptor's words, "an attempt to restore it to the fulness of its original beauty and splendour." The scheme is one, especially in its latter portion, which demanded for its successful execution a rare combination of sobriety and enthusiasm. Any merely conjectural re-construction could have satisfied none of the serious demands of the subject; while it would have been an unpardonable assumption, that affected to clothe the fancy of the artist with the sanctions of the highest authority known to art. Luckily, the material and other documents yet exist in sufficient distinctness and abundance to furnish certain evidence, for the conscientious student, as to the general plan and many of the details of this great temple,—and, for the sound and accomplished artist, reasonable inferences as to the rest. Mr. Lucas has carefully consulted the authorities on the subject—both those of fact and speculation—remains and drawings of remains, with the opinions of scholars as to the interpretation of these where their language is obscure: and where, all these failing him, it has been necessary to connect the known by the unknown, he has taken the principles upon which Phidias wrought for his guide, and sought only in what is expressed for what is meant. In this species of questioning he has shown great judgment—generally winning the assent of the critic to the testimony which he makes ths monument bear of itself. A passionate worshipper at that shrine of Art which he has chosen, he is, nevertheless, careful that his worhip shall approve itself as a reasonable service; his undisguised enthusiasm for his task is not imported into it from without,—but born legitimately of the embodied principles before him, and appealing to their qualities of fitness and beauty for its justification. Better discipline, teaching more sure and sublime than this, the sculptor could not propose to himself; and, amid that visible want of earnest thought—that general defect of spirituality—which may have some excuse in the long tendencies of public patronage amongst us, but by which the school is held back from the high destinies awaiting it, we see with more than ordinary pleasure this patient and zealous search into the fountains of the true in-

Art and the immortal in thought. In the progress of his labour, Mr. Lucas has made sure acquaintance with principles which are likely to have an elevating effect on all his future works; and, better still, what he has found, he has commemorated—embodying, for the use of others, the instruction which he sought for himself. We have here, by his means, the text of the Parthenon restored, with fewer conjectural readings (and those, certainly, for the most part, true in their character) than might have been hoped; and, in this view of the matter, we rejoice that the British Museum has purchased the model of the completed building—to stand in the Elgin Gallery, as a key to the matchless remains which are so many of the original parts, and an important element of this restoration.

The faded and, to the uninstructed eye, somewhat enigmatical character of these remains will be more fully understood by the public, and more readily by the artist, in this easy reference to their context; the meaning of the restored whole more readily suggests the meanings of the several parts. The amateur may here catch the full expressions, and the artist the true canon, of Greek sculpture. In this point of view, the reading-made-easy of the Parthenon, with its sculptures, is an invaluable lesson set up in our schools of Arts. While the mere sentiments of the Arts finds here its full satisfaction in perfect beauty of forms, the intelligent student perceives how little the secret of that satisfaction is dependent upon the forms themselves. The principles of art are all summed up in this great and perfect work; yet the work, while involving all the truths which are necessary to perfection, is not the truth itself, but only one perfect and harmonious form of its expression. The careful reader of this magnificent poem, with the full epic before him—who sees how its endless varieties of detail all tend to the production of one great unity of thought, cannot overlook the leading secret which lies at the bottom of all excellence in Art,—and so takes a lesson which has been greatly needed in the modern schools. In every page of this matchless book is enforced the great and eternal principle of *fitness*. No single word has the chisel written on this immortal volume which has not a meaning—and those meanings are *one*, and such as could be directly understood and fully tasted by the national heart to which they are addressed. He who takes these mere forms, and reconstructs them in the heart of London, is but the anatomist of sculpture—and scarcely that; the resurrectionist who produces from its tomb the skeleton of Art—a worthless thing, now the living soul is gone out of it. The secret of their meaning in Greece is that of their no-meaning here; and the sculptor learns, from such works themselves, that he can, for the most part, only adopt the principles of the Greek by rejecting his combinations. The language of Art, when rightly learnt, will be found to be universal—and, therefore, universally intelligible; but he who has wholly different things to express must seek wholly different expressions. The Gods of Greece, who were all at home upon their own Athenian hill, are strangers, every one, in the streets of London and Paris. The true teaching of Greek sculpture forbids to copy it. The letter of Greek Art is a dead thing, amid the changes of the world; but its spirit is immortal amid the ruins—and speaks and breathes from every mutilated page of this great book.

The materials which Mr. Lucas has had to assist him in his work of restoration are the drawings made by Carrey, in 1675, for the Marquis de Noistel, before the Parthenon suffered its last great dilapidations at the hands of the Venetians—the work of Stuart and Revett on Athens, who saw the ruin in 1751, when the Ilissus and the Torso of the group of Cecrops and Agraulaus maintained their place in the western pediment—the comparatively perfect condition of the eastern pediment itself, as drawn by all these artists; from which Mr. Lucas has deduced very ingenious consequences of his own for a restoration of the eastern pediment, in opposition to those of Quatremère de Quincy and Edouard Gerhard, and differing from those of Lusieri and Mr. Cockerell—the scanty hints of Pausanias—the works of Spon and Wheler, the Chevalier Brondsted and Professor Welcker—the advice and arguments of Colonel Leake, Professor Cockerell, Mr. Hawkins, and Mr. Pittakis, the present curator of the Parthenon—and the most invaluable document of all, the actual remains in the Elgin Room of the British Museum. The principal question which presented itself for solution was that of the eastern pediment—of which Pausanias merely says that it related to the creation of Minerva; while the western had reference to the contest of that goddess with Neptune for the territory of Attica. In the latter case, however, the drawings of Carrey, made from the sculptures themselves when the pediment was nearly perfect, are better evidence of the intentions of Phidias than the casual remark of Pausanias,—and demonstrate that his expression will not strictly describe their subject. It is evident that the victory of Minerva in this contest, rather than the actual contest itself, is expressed in the pediment in question: and Mr. Lucas demands merely a similar latitude in the correction of the loose language of Pausanias, as the basis of his restoration of the eastern pediment. A liberal construction of the word γενεσις, he contends, will render it unnecessary to suppose that the very *act* of the creation was intended to be described as the subject,—and will let in any of the incidents attendant upon that great mythological event, the advent of Minerva. But it is to be observed, that it is not in the mere idle spirit of speculative amendment that this correction is proposed, but under the compulsion of the principles on which Phidias wrought, as written in every other part of this great work. "Keeping," says the sculptor, in some printed remarks on the Parthenon, wherein he has very ably stated his own views, "stedfastly in our minds the means by which Phidias has produced so sublime a result in the western pediment, we will endeavour to approach the eastern one in the same spirit. The manner and method in which the myth was represented in the western pediment open to us the understanding of the easter pedimental composition; and if we apply this mode of viewing the subject to this eastern pediment (of which we have noticed the entire destruction of the central portion in the early times), we may feel quite sure that the myth must have been treated in a manner equally satisfactory. . . Hence we have little doubt that the restoration of the eastern pediment, proposed by Brondsted and executed by Quatremère de Quincy, where Vulcan is represented as having cleft open the head of Jupiter, and one of the two goddesses who preside over births is drawing out a little figure of Minerva, while the other is supporting Jupiter as though he were fainting under the agonies of child-birth, can never be an adequate expression of Phidias's own design. It may be said that Homer's description is sufficient warrant for Q. de Quincy's restoration; yet still we feel that the strict letter of the poet is inapplicable to pedimental composition. Homer describes the glorious form of Minerva as rising from the brain of Jupiter, and all Nature struck with awe at the splendour of her form and golden plumage; but in the adaptation of that moment to sculpture, the glorious form of Wisdom sinks into an insignificant puppet. And hence we have no reason to suppose that the existence of such a subject on a patera (itself taken from a picture) was any motive with Phidias for the selection of that which, as well from scantiness of space as from unfitness of material, could not be treated with propriety. Nor did the incongruity of the French conception of the subject escape the eye of Flaxman; who, in his lectures, observes, that the composition was no doubt filled, not by a representation of the *actual* birth of Minerva, but rather, as would be far more fitting in a temple peculiarly dedicated to her honour, by the introduction of the goddess to the august assemblage of the gods on Olympus—a subject in the highest degree imposing, and admitting of a sculptural treatment of the greatest majesty. And this view of the subject is also taken by Mr. Cockerell; who has demonstrated that the fragment on the floor of the Elgin Room was the base of the statue of Minerva in the eastern pediment—a judgment in which M. Welcker entirely coincides with him."

This view of the matter Mr. Lucas has himself adopted; and out of such fragments as remain, with what we know positively from Carrey of their place,—supplying the blanks from inferences and reasonings whose artistic soundness are deserving of great commendation—he has reconstructed the whole into a splendid composition; which, if not the true one, is certainly in a Greek spirit,—and where the parts filled up offer no discord with what remains of the ancient text.

One valuable lesson Mr. Lucas has drawn from the consideration of these pediments—which we must not omit. The sculptures that adorn them—or rather of which they are *composed*—so far from being arbitrarily confined within the pedimental lines, as barriers which the genius of the sculptor must not venture to infringe—a practice that gives to the figures on pediments in general the character of mere after-thoughts for the embellishment of the building, are here, by latitude in the size and projection of the figures, not only made to seem an original and expressive part of the great intention, but the effect of a bold and beautiful variety to the eye is thus obtained by the same simple act of mastery which gives this addition to the unity of the thought. "I have the highest authority," says Mr. Lucas, "for stating that not one modern pediment has been constructed in accordance with the rules which this pediment of Phidias prescribes to us; and as to the sufficiency of this example as a rule, we have the united testimony of all authorities on the subject, that this pedimental construction contained the result of seven hundred years' experience,—and that used by the discretion of Phidias."

We cannot follow Mr. Lucas at length, through all the parts of his restoration. The frieze is recomposed in its entirety, on the outer wall of the cellar—the existing parts being made to suggest the lost. The columns are restored to the interior in a double row, Mr. Lucas having finally decided, as a choice amongst difficulties (for this is the point on which the evidence is most contradictory and the decision the least satisfactory), on Corinthian placed above Ionic. The Goddess is replaced in the glorious shrine which was built up for the sole purpose of containing her idea, in her garment of ivory and gold, and with her rich sculptural accessories, as described by Pausanias and seen on ancient coins and gems. The missing metopes are restored, the subjects supplied being in every case sought from coins and vases, and for this purpose on a principle of connexion suggested by a judicious consideration of those which exist, in fact or in drawing. Even the shields, of whose former presence on the exterior of the temple the traces remain, are here replaced,—though nothing can be known of the devices which they contained—that no feature may be wanting to convey the general effect of the whole. The adoption of these devices is, therefore, confessedly, quite conjectural—but not quite arbitrary, notwithstanding. They have been selected from vases, coins, and the work *Monumens Inédits*, published by the Institute of Rome, which contains a large number of the shields of Minerva. Nothing has been left out that could be authenticated,—or restored upon presumptive testimony furnished by the temple itself. Only in the case of the Polychromatic adjuncts, of which evidence is supposed to exist, has Mr. Lucas (with that same sobriety of judgment which has ruled his enthusiasm throughout this work,—and which is but the deep passion for his theme, chastened by the reverence with which he approaches it,) refrained—because, as he says, it cannot be demonstrated that they were as early as the period of Phidias—and because, "as it appeared to me to impair the chasteness of the temple, I am not called on to run any risk of making a gaud of this restoration of the Parthenon, or to depart from that severe simplicity which is the characteristic of all the art of Phidias."

In one other point of view, we rejoice at the adoption of this model by the Museum;—we think it calculated to help the sculptor to his place in England, and inspire him with the determination to take it. Nowhere does the genius of sculpture seem so *great* as in the Parthenon. There is no other work in which its marvels have been turned to such epic account; and though we hesitate to go all the way with Mr. Lucas, who supposes the temple itself to have been designed as a mere pedestal for the foot of the Genius—a frame for the sculptor to work on—yet certain it is that if, in this unrivalled union of the Arts, there be one spirit that presides over the others with authority, it is sculpture. But the true lesson taught by this temple is the *oneness* and entirety of Art—the joint and harmonious contribution of its several forms to the production of a great whole—the embodiment of a perfect thought—in proportions varying with the demands of the particular subject. That splitting into separate members of the great family of Art, which has left something unsatisfactory in its best achievements in England, is authoritatively rebuked in presence of this majestic result produced by their combination. Most of all, in this presence, is that ignorant error detected which has assigned to sculpture, amongst ourselves, a lower place than the highest in Art. By academicians who have given it the coal-hole, it is well it should be seen here with the glory on its brow; and the sculptor who is content to work as the mere decorator to the architect—called in to ornament, as with mere artistic surplusage, *his* finished and self-reliant design—may learn how, as a master, sculpture wrought in Greece. The architect and the sculptor, where they are not *one*, must *plan* together. Sculpture must be a portion of the *soul* of great architectural works, not their garment, ere the one or the other can achieve, with us, the marvels which have testified so long in vain of the old Greek spirituality. Till sculpture shall be architectoric, its great destinies cannot be accomplished amongst us. The sculptor who comes fresh from the study of the Parthenon will feel that he is a minister in the very highest place of Art; and the public, instructed by the same great revelation, will, if the former be true to himself, help to get him his own again in the new era of Art which is dawning over England.

The other model is as yet unfinished—and unpurchased. We trust the Museum will add it to the other; and shall have some words to say of it when complete. The models are, severally, twelve feet in length by nearly six in width.

REGISTER OF NEW PATENTS.

If additional information be required respecting any patent, it may be obtained at the office of this Journal.

John Cleveland Palmer, of East Haddam, for "*Improvements in machinery for making augurs*," &c.—Granted March 17; Enrolled September 17, 1845.

The object of the mechanism is for manufacturing the "single twist" augur, usually made of a rod of metal, twisted round a cylinder into a helical curve. The augur which the inventor's machinery is intended to manufacture is to be formed of a long rod of metal (either of a triangular or other proper shape, in its cross section). The iron should be rolled in square bars or rods, of the size required, and be cut into pieces of sufficient length, to make the tool or instrument intended. A small piece of steel of proper size for the cutting lip, (and the conical screw, if it is to be added,) is next welded upon one end of each one of the said pieces, and the end is next turned or bent down, at right angles to the remainder, upon an anvil, so as to fit into the cavityof the lower section of the dies, for forming the lip, or the lip and screw cone. About three-fourths of the length of the rod from the steel knob, is next heated to the necessary temperature, to be rolled down by the next portion of the machinery. The next portion of the process of manufacturing the augur consists in forming the cutting lip, or the cutting lip and conical screw blank upon its end. For this purpose, dies are employed to form the lip without the conic blank. The head of steel being heated, is placed between the dies, and the upper of them caused to descend, with the force necessary to swedge or compress the metal into the shape required. The knob thus formed, is next bent down to the angle required, to be applied to the machine, by which the rod is twisted in the helical curve. The next operation is, to give the requisite degree of uniformity to the size and spread of the twist, which is accomplished by hammering in the machine, consisting of a trip hammer, arranged and operated over and upon a die anvil or bed-piece, grooved out, so as to receive the twisted helix when laid thereon. By turning the augur around, first in one direction and next in the opposite, successively, so as to cause it to pass back and forth between the hammer and bed-piece or anvil, the twist is spread out in a uniform manner. The lower part of the hammer should be curved to correspond with the circumference of the exterior of the twist of the augur. The twisted portion of the augur is again heated, and rolled between heavy iron plates, for the purpose of straightening the twist, during which operation, care should be taken that the cutting lip of the augur does not come in contact with the plates. The augur is next to be finished by filing, and upon grinding and polishing wheels, or by other proper means, in such manner as may be desirable; and when a screw is to be connected with the cutting lip, it may be cut upon the blank by any contrivance adapted to the purpose.

William Robinson Mulley and George Mason, jun., of Ipswich, contractors, for "*Improvements in collecting and raising stone or substances from below water.*"—Granted April 2; Enrolled October 2, 1845.

This invention is chiefly intended for raising cement stone from below water off West Rock, near Harwich, or other places similarly circumstanced, which at present is performed by sailing vessels, the dredging bags being raised by manual labour. The object of this invention is to apply the power of steam in a suitable vessel to drag dredging bags, and to raise them and cement stone, or other matters collected thereby, into the vessel.

Thomas Moss, Esq., of Gainsford-street, Barnsbury-road, for "*Improvements in printing and preparing bankers' notes, cheques, and other papers, for the better prevention of fraud.*" Granted, April 22; enrolled October 22 1845.

This invention consists in impressing patterns on the surface of paper used as bankers' notes, and other documents, on which designs or letters have been or are intended to be printed, that the paper so treated will be smooth on one side, whilst the other side will have a pattern indented thereon, so as to produce the appearance of a reticulated surface. The apparatus consists of a pair of steel rollers, one plain and the other engraved with the reverse of the pattern to be formed on the paper; and pressed heavily down upon the plain roller. The paper then becomes indented with the pattern or design; and if the engraved roller be inked, as in surface printing, the indented pattern will at the same time be coloured.

Joseph Hill, of Ipswich, Suffolk, wireworker, for "*Improvements in manufacturing wire fabrics for blinds and other uses.*" Granted May 6; enrolled November 6, 1845.

The first improvement consists in giving a corrugated form to woven wire fabrics, to obtain greater stiffness, and render them more useful for making blinds, and other purposes. The corrugated form is given by passing the wire between two grooved iron rollers; the side of the corrugations will generally vary from ½ to ⅝ inch. The second improvement consists in submitting woven wire fabrics to a process of embossing, so as to produce ornamental patterns thereon. A die is formed of brass or other metal, with the pattern upon it in relief; over this is placed a sheet of "vulcanized India-rubber," ¼ inch thick; and then, by means of a powerful screw-press, the wire fabric is pressed down upon the die, and the required embossing is produced. The employment of the India-rubber renders a counter die or matrix unnecessary; and the same sheet of India-rubber may, as it is plain, be used with different dies.

Frederick Ransome, of Ipswich, engineer, for "*Improvements in combining small coal and other matters, and in preserving wood.*" Granted May 10; enrolled November 10, 1845.

The invention consists in combining small coal with a solution of silica or siliceous cement, made by dissolving 100lb. of crystallized carbonate of soda in as much water as will make a solution of 1,150 sp. gr. at a temperature of 60°, and the soda is rendered caustic by the addition of lime; or, instead of carbonate of soda, 50lb. of carbonate of potash are dissolved in the requisite quantity of water, and rendered caustic by means of lime. This caustic alkaline solution is introduced, along with about 100lb. of finely-broken flints or other siliceous substances, into an iron boiler or digester, and the mixture is kept for ten or twelve hours at a temperature of about 300° Fahr.. being at the same time frequently stirred. When sufficiently incorporated, the mixture is passed through a sieve, to remove any undissolved stone therefrom, and it is then evaporated until its specific gravity is increased to 1,500, at a temperature of 60°. The cement or solution is now fit for use; or, if too thin, it may be brought to the required consistence by evaporation, or by the addition of sand, or of calcined flints in a finely-powdered state; if too thick, it can be reduced with water. The mode of combining small coal into blocks is, by mixing any suitable quantity of coal-dust or small coal with from $\frac{1}{20}$th to $\frac{1}{10}$th of its weight of the siliceous cement, which is put into moulds, and subjected to pressure; after which it is allowed to dry in the air, and then placed in an oven or hot room. For pressing timber, the wood is saturated or impregnated with a solution of silica, in such a manner as to cement the fibrous part of the wood with the silica, so as to form a solid and durable mass. The wood is placed in an air-tight vessel, from which as much air is abstracted as is practicable, by an air-pump or other convenient means; a sufficient quantity of siliceous cement to cover the wood is then admitted, and, in order to cause the cement to penetrate further into the pores of the wood than would be effected naturally, artificial pressure is applied, by means of a pump; when removed, the wood is immersed in some acidulated or saline solution, which will render the silica insoluble.

RAILWAYS OF BELGIUM.

By John Anderson, Esq., F.R.S.S.A.

(Abridged from a Paper read before the Royal Scottish Society of Arts.)

The accumulated length of the Belgian railroads amounts to 348 miles. They consist partly of a double and partly of a single way of 4 ft. 8½ in. betwixt the rails of the track, and a distance of 6 ft. 6½ in betwixt the railroads.—The following table gives the length and cost of the different lines, the stations thereon, and the total cost of the whole establishment:

Lines.	Length of Lines.	Cost of Lines.	Cost of Stations per Line.	Total Cost.	Cost per Mile.	Remarks, with reference to the Estimates.
		£	£	£	£	
Brussels to Antwerp (including branch from the station of Borgerhout to the Scheldt)	29·028	303,378·12	228,061·48	531,439·60	18,308	Double way.
Malines to Ostend	76·025	633,350·24	84,847·76	718,198·00	9,447	Double way to Ghent.
Malines to Ans (including branch to the Canal at Louvain)	55·100	743,458·92	42,658·08	786,117·00	14,267	Double way.
Ans to the Prussian frontiers (including branch to the interior of Liege)	29·500	1,240,303·47	132,400·00	1,372,703·47	46,532	Double way to Verviers.
Landen to St. Trond	6·350	48,336·72	6,823·08	55,159·80	8,686	Single way.
Ghent to Courtray	27·130	170,923·88	17,900·00	188,823·88	6,960	Single way.
Courtray to the French frontiers	9·359	131,000·00	8,920·00	139,920·00	14,950	Double way.
Mouscron to Tournay	11·890	111,560·00	10,520·00	122,080·00	10,267	Single way.
Brussels to Quiévrain	50·127	648,875·94	99,011·96	747,887·90	14,920	Part double way.
Braine-le-Comte to Namur	50·699	563,239·39	75,800·00	639,039·39	12,604	Single way; but embankments for a double way.
Junction of Stations at Brussels	2·914	29,546·04	..	29,546·04	10,139	
	348·122	4,623,972·72	706,942·36	5,330,915·08	15,313	
			Material of Transport ..	823,921·12		
			Total General Expense..	6,154,836·20		

Up to the end of 1842, 271·587 miles had been constructed; and in the autumn of last year the first way, and probably more, of the remaining lines had been completed. On taking an average of the cost of the British railways, it will be found that those in England cost fully double, and those of Scotland and Ireland fully a third, more than those of Belgium. Even the French railways, on the following average, are constructed at nearly double the expense of the Belgian lines:—

		Per Mile.
The line from	Lyon to St. Etienne cost, in round numbers	£19,000
..	Paris to Versailles - -	26,000
..	Paris to St. Germain - -	30,000

In the Belgian lines, both parallel and *fish-bellied* rails are used. There is nothing particular in their mode of laying them down. The ballasting consists of sand and gravel, and, from various circumstances, formed a considerable item in the expenditure:—

			s.	d.	
Between	Waremme and Ans,	it cost	8	5¼	per cubic yard.
..	Louvain and Tirlemont	..	6	9¼	..
..	Tirlemont and Waremme	..	5	6¼	..
..	Denyze and Courtray	..	5	1	..
..	Landen and St. Trond	..	4	7	..
..	Malines and Antwerp	..	3	11¾	..
..	Malines and Termonde	..	3	10¾	..
..	Ghent and Deynse	..	3	10	..
..	Bruges and Ostend	..	3	6¾	..
..	Malines and Louvain	..	2	8¼	..
..	Termonde and Ghent	..	2	8	..
..	Ghent and Bruges	..	2	7½	..
..	Brussels and Tubise	..	2	7½	..
..	Malines and Brussels	..	1	11¾	..

Weight and cost of rails.

The rails were furnished in 1834-35-36-37, and at different times in the following years, in lengths of 15 feet, 16·4 feet, and 14·8 feet. Those of 15 feet were furnished of different weights, weighing 40·1 lb., 39·7 lb., 35·3 lb., 43·7 lb., 54 5 lb. to the lineal yard; those of 17·4 feet weighing 50·4 lb., and those of 14·8 feet weighing 50·4 and 48·8 lb. to the lineal yard. The whole rails are of the manufacture of the country, with the exception of about 200 tons, which were brought from England in 1834, to serve as models. Their price during the first four or five years varied very much; no doubt from the competition to which the extensive demand give rise. The ton of rails, which could be furnished at Malines, for instance, in 1834, for 14*l.* 12*s.* 6*d.*, rose to 15*l.* 4*s.* 6*d.* and 18*l.* 1*s.* 6*d.*, and descended again to 17*l.* 1*s.*, 13*l.* 16*s.*, and came even so low, in 1840, as 10*l.* 6*d.*, but rose again the same year to 11*l.* 3*s.* 6*d.* Those, however, produced in 1840 were much inferior to the rails first manufactured in the country. Until 1838, chairs, keys, and spikes, were furnished with the rails; but since that time the contractors have bargained to supply them separately. The ton of chairs, in 1834, was supplied at 10*l.* 7*s.*, but rose the year following to 10*l.* 15*s.*, and, in 1836, to 12*l.* 16*s.*, 13*l.* 4*s.*, and 14*l.* 4*s.*; and. in general. fluctuated with the price of rails. Keys and spikes, in 1834, cost 22*l*, 7*s.* per ton, and rose the following year to 24*l.* 3*s.* 6*d.*, 21*l.* 11*s.* 6*d.* In 1826-7, they varied from 28*l.* 9*s.* to 30*l.* 1*s.*; and, in 1838, came down, after many fluctuations, to 24*l.* 7*s.* 6*d.*, and 23*l.* 19. 7*d.* In short, the cost, in general, likewise varied in proportion with the rails and chairs.

Principal Works.

From inexperience or oversight, the section from Brussels to Malines was made upon so low a level that it was often overflown by the Senne, which greatly damaged, and sometimes even perfectly obstructed, the railway. The rails, moreover, were too weak, and the sleepers made from white and pine wood. From these circumstances, it became necessary to raise the railway at least upwards of a foot and a half, and protect the banks, and form viaducts through which the waters could flow. The old rails were nearly all thrown aside, and others of greater strength laid down, and the sleepers subjected to M. Boucherie's process for the preservation of wood. Between Brussels and Quiévrain, the ground on several sections consists of peat, and bogs; on this account it has been necessary to build a greater part of the bridges on piles, and raise the railway in some places 13 feet; the tunnel of Braine-le-Comte is 16·4 feet of span, and 25·7 chains in length.

From a short distance from Malines the railway begins to ascend to Ans. The works upon the line, though numerous, are light. The greatest undertaking is the tunnel of Cumptich, which has been lately constructed for the double way. It is entirely built of brick, and is 20·6 feet in height, and 45·73 chains in length. The heavy works, however, of the Belgian railroads only begin at Ans, where the railway descends into the valley of the Meuse.

The Liege Incline.

Ans stands upon the west bank of the valley of the Meuse, about 581 feet above the level of the sea; and Liege is situated in the bottom of the valley, about 358 feet below Ans. The distance betwixt Ans and the Meuse at Liege is 4 miles 9 chains, thus making on the length of the line the general gradient about 1 in 60. To descend this valley was a matter of no little difficulty, and it was only after many years' study, in which time numerous projects were examined, that the administration saw the necessity of descending it by inclined planes. The plan adopted by them consists of two inclined planes of equal lengths, with a platform or level space of ground, on which the engines are placed, situated at the bottom of the first and the summit of the second incline. The platform is about 16¾ chains in extent, and the inclines 1 mile 1¾ chains each of length, of a rise of 1 in 36, both of which are constructed with a double way, the one being employed for ascending, and the other for descending. Referring to the section, the railway proceeding from Ans describes a curve of 1 mile 37 chains of radius, and descends the first incline. Having crossed the platform, it descends the second incline, and arrives at the principal station of Liege. The trains descend the inclined planes by gravitation, their velocity being regulated by drags attached to the carriages and wagons. Two fixed engines, of 160 horse power each, are placed on the platform for raising the trains, which is accomplished by means of an *endless rope.* Both engines being situated close together, are supplied with steam from the same boilers. The system of signals, we are told, they employ, is somewhat novel:—A tube of fully one inch diameter is laid along the railway. Each of its extremities communicates with the interior of a bell, the mouth of which is immersed in water. Into the top of the bell a whistle is fixed, which, as in the case of the locomotive whistle, acts by the vibration of the metal. When it is required to communicate the time of departure of any of the trains from either station, the signal-man has only to shut off communication with the whistle, and immerse the bell further amongst the water. The air in the one bell will thus be forced, by pressure, through the tube into the other bell at the further end of the tube, and will escape by passing through, and at the same time acting upon, the whistle.

Nothing strikes the traveller so much with astonishment, when he descends the valley of the Meuse, and enters that of Verviers, as the contrast the face of the country presents to that which he a few minutes ago left. The scenery, indeed, as soon as he leaves Ans, is entirely changed. Instead of the flat and monotonous country through which he has just passed, he is ushered into a finely varied district of hills and valleys. The number and extent of the different works of art he observes, tell him also of the nature of the country through which he is passing, and the difficulties which the engineer encountered in the execution of this part of the national system of railroads.

It may be remarked, that, in the execution of the different works of art throughout the different lines, the workmanship is inferior to that of similar undertakings in this country; and that also in their construction, due attention has always been paid to the fortifications of the towns by which the railway passes.

Curves and Gradients.

The curves and gradients, as necessarily follows, from the extent of the different lines, vary very much, and present many of the results which arise from their existence on railways in general. The radii of the principal curves are as follows:—3·73 chains; 9·44 chains, (both on the branch of Louvain to the canal); 9·94 chains; 12·43 chains; 17·4 chains; 18·14 chains; 19·88 chains; 24·25 chains; 29·83 chains; 34·8 chains; 37·28 chains; 39·77 chains; 43·74 chains; 44·74 chains; 49·71 chains; 54·68 chains; 59·65 chains; 62·14 chains; 67·1 chains; 69·59 chains; 72·58 chains; 74·56 chains; 79·54 chains; and 1 mile 4·5 chains.

The most important gradients are:—

That towards Waremme, at the station of Landen, of 1 in 241, of 2 miles 39 chains in length.—That towards Tirlemont, at the station of Louvain, of 1 in 250, of 3 miles 58 chains in length.—That between Tubise and Braine-le-Comte, of 1 in 200, of 5 miles 47 chains in length.—That on the branch from Louvain to the canal, of 1 in 71, of 32 chains in length.—That betwixt Jurbise and Braine-le-Comte, of 1 in 250, of 4 miles 3 chains in length.—That betwixt Mons and Jurbise, of 1 in 250, or 6 miles 42 chains in length.

Stations.

The stations throughout the different lines are numerous, and, in general, neat and commodious buildings. Antwerp, Brussels, Malines, and Ghent, are reckoned of the first order, and contains the warehouses and arsenal for provision and material. Ample accommodation is set apart in them for passengers; one large room being always devoted to first and second, and another to third class, passengers. The next stations in importance to these are, Bruges, Termonde, Louvrin, and Tirlemont; and then the minor stations upon the different subdivisions of the line. Malines was, from the very first, chosen as the central station through which the greatest number of passengers was expected to flow; and it was also fixed upon as the workshop for the repairs of the heavy machinery, and of the railways in general throughout the country, the workshops at any of the other stations being only of a secondary importance. But, notwithstanding its many advantages, Brussels has become the principle station, and draws one-fourth of the receipts of the whole of the different lines. In consequence of this unexpected result it became necessary to build a more extensive station at the north of Brussels. The stations, with the exception of Ostend, Bruges, and Ghent, are placed without the towns, for the purpose of evading the local taxes, which can only be accomplished by placing them beyond the boundaries of the excise. Tickets for the trains are issued from the windows of the different offices; and, to avoid confusion during a crowd, stalls are erected, through which the passengers pass one by one, receive their checks, and return by a passage parallel to the one by which they entered. If the traveller has luggage exceeding 44 lb. weight, he has to proceed to the luggage depôt, where it is weighed, and he is charged a trifling sum per lb. Upon paying this sum he receives a ticket with a number marked upon it, corresponding to one which is put upon his luggage. From this time he sees no more of his property until he arrives at his destination, where it is brought from the luggage-wagon, and the number marked upon it called out by one of the officers in attendance, who returns it to its owner on presenting the ticket which he had received.

Locomotive Engines.

The locomotive engines, at the 1st of January 1843, were 129 in number, 42 of which were made in England, and the remainder in Belgium. Of these, 95 are in good working order, and 34 undergoing repairs. In addition to these, however, 10 were in course of being constructed, which will make, in all, 139. The following table gives the makers' names, and the number each has made, with the diameter of the cylinders and driving wheels:—

Makers' Names.	Diameter of Cylinder.	Diameter of Driving Wheels.	Number of each Size.	Number by each Maker.
England.				
Stephenson	11 inches	5 feet	8	30
	12 ..	5 ..	6	
	12¼ ..	5½ ..	1	
	12½ ..	5½ ..	7	
	14 ..	4½ ..	7	
	14 ..	5 ..	1	
Longridge and Co. ..	12½ ..	5½ ..	10	10
Fenton and Murray ..	12 ..	5 ..	1	1
Sharp, Roberts, and Co. ..	12 ..	5 ..	1	1
Belgium.				
Cockerill	11 ..	5 ..	12	69
	12 ..	5 ..	27	
	12½ ..	5½ ..	20	
	14 ..	4½ ..	10	
Soc. St.-Léonard ..	12 ..	5 ..	4	7
	13 ..	5½ ..	3	
Soc. du Renard ..	12½ ..	5 ..	1	11
	12½ ..	5½ ..	5	
	13 ..	5½ ..	5	
			Total..	129

Fuel.

The coke required for the consumption of the locomotives is manufactured at Monplaisir, Malines, Antwerp, Ghent, Ostend, Ans, and Hal; and costs at these places respectively, 1*l.* 4s. 2½d., 1*l.* 3s. 11½d., 1*l.* 7s. 7¾d., 1*l.* 3s. 8½d., 1*l.* 5s. 2½d., 17s. 0¾d., and 1*l.* 1s. 5d. per ton. The quantity consumed in 1841, in running over 927,080 miles, was 29,303 tons, or 70·80 lb. per mile. This is including, however, the quantity required for the *reserve* and *lighting*, which amounted to 4399 tons, and which, if deducted, will make the consumption 60·17 lb. per mile. In 1842, the distance run over was 987,432 miles, and the total quantity of coke consumed was 28,317 tons, or 64·24 lb. per mile. The quantity required for the *reserve* and *lighting* was 5635 tons, and which, if deducted, will make the consumption 51·46 lb. per mile.

Carriages.

The carriages consist of three classes, as they do in this country, but are much more commodious, and, in some cases, vastly superior in comfort. For example, second class carriages possess not only windows, but the seats are cushioned, and almost as comfortable as those of the first class, though, perhaps, a little less elegant. Even third class carriages have covered seats, and very often roofs supported upon perpendicular iron rods fixed at the corners of the carriages. The seats are placed transversely, and without any proper mode of entrance, which is a great inconvenience to passengers; and the doors are, in every case, unlocked, but are held close by a catch, which can be opened and shut from either side of the carriage.

The rate of travelling, generally, is about 20 miles per hour; but on some lines, on account of the gradients, it varies from 19 to 25 miles per hour.

Power of the Engines on Inclines.

The greatest gradient, with the exception of that betwixt Ans and Liege, is 1 in 71 on the branch from Louvain to the canal. A locomotive, of a 12½ inch cylinder, and driving wheels of 5½ feet diameter, can ascend this slope with a train of three loaded and three empty wagons, of a total weight of about 44¼ tons; but a locomotive of a 14 inch cylinder, with coupled driving wheels of 4½ feet, can ascend it with six loaded and three empty wagons, of a total weight of about 69 tons, the rate of travelling in both of these cases being three miles per hour. From a curve in several parts of this line, however, of 3 73 chains of radius, it is thought to be more convenient to work it with horses. A strong horse upon this incline can draw a wagon of about six tons weight, at the rate of 2¼ miles per hour.

On the inclination betwixt Tubise and Braine-le-Comte of 1 in 200, two trains, of 16 and 17 carriages each, with a total weight of 88½ to 98½ tons, and a locomotive of a 12½ inch cylinder, and driving wheels of 5½ feet diameter, were unable to proceed in unfavourable weather. At another time, equally unfavourable, an engine of the same size took up two trains of 13 and 11 carriages each, with a total weight of about 88½ and 78¾ tons, with great difficulty. On the inclination betwixt Jurbise and Soignies of 1 in 250, two trains, of 12 and 13 carriages each, with from 78¾ to 88½ tons, and an engine of the same dimensions could not ascend. A third, however, with 13 carriages of 88½ tons, succeeded in mounting the slope.

From these observations it was concluded, that the greatest weight with which an engine of a 12½ inch cylinder, and driving wheels of 5½ feet diameter, can ascend either of these inclinations, is from 88½ to 98½ tons in ordinary weather, but otherwise with only from 73¾ to 78¾ tons. With the same of cylinder, however, either of these inclines can be ascended with 69 tons, at a velocity from about 12¾ to 15½ miles per hour; or, with an engine of a cylinder of 14 inches diameter, about 108½ tons can be taken up, at the rate of about 12¾ miles per hour.

On the inclination betwixt Lonvain and Vertryck of 1 in 250, the following trains ascended with difficulty in unfavourable weather :—

Locomotive.	Inch cylinder.		Feet.	Carriages.	Tons total weight.
1	14	with coupled driving-wheels of	4½	20	137½
1	14	..	..	23	147½
1	12	not coupled ..	5	16	98¼
1	14	coupled ..	4½	18	137½
1	14	.. ..	..	24	147½
1	14	.. ..	..	39	270½
2	14	.. ..	..	18	118
1	14	.. ..	..	22	137½
1	14	.. ..	..	22	137½
1	14	.. ..	..		

From these experiments it was concluded, that a locomotive of a 14 inch cylinder, and coupled driving wheels of 4½ feet diameter, could ascend this incline with difficulty in ordinary weather, with from 137½ to 147½ tons, but during times of snow with only 69 tons; and a locomotive of a 12 inch cylinder, with driving-wheels of 5 feet diameter, not coupled, could ascend, in ordinary weather, with from 78¾ to 98¼ tons, and in times of snow with from 44½ to 49 tons. They ascend this slope regularly, however, with trains of 73¾ and 108½ tons, including the weight of the locomotives of 12 and 14 inch cylinders, about the rate of 15½, and from 12¾ to 15½ miles per hour.

The whole railway buisness is under the management of a director, who is under the control of the Minister of Public Works. It is divided into four branches—namely, the general management of the whole system; the management of the lines; the locomotive department; the traffic of the railway; and the management of the stations. The first of these, generally speaking, includes the other three, one of which consists in the management of the lines, and the finishing and constructing of new works of art; another in the traction of the trains, the manufacture of coke, and the management of the arsensal at Malines, including the workshops for repairing the locomotives and carriages; and the third, in the management of the stations and the passenger and merchandise traffic. Over each of these four departments a functionary, entitled Engineer-in-Chief, or Inspector of Administration, is placed, who furnishes an account of the proceedings of his department to the Minister, and makes such proposals to him as he thinks necessary or advantageous. The propositions he submits are sent for examination to the Council or permanent Commission of Ways and Bridges. Besides the surveillance exercised by the director, and the agents under his orders, the Minister causes all the works to examined by the Inspector-General, and by the Divisionary Inspector of Ways and Bridges; and with the documents received from the different departments, renders an elaborate report of the whole business annually to the Chamber of Deputies.

ICEBERGS OF THE ANTARCTIC SEAS.

"Icebergs were seen in all stages of formation, from five to two hundred feet above the surface, and each exposed its stratification in horizontal layers, from six inches to four feet in thickness. When the icebergs are fully formed, they have a tabular and stratified appearance, and are perfectly wall-sided, varying from one hundred and eighty to two hundred and ten feet in height. These were frequently found by us in their original situation, attached to the land, and having the horizontal stratification distinctly visible.

"In some places we sailed for more than fifty miles together along a straight and perpendicular wall, from one hundred and fifty to two hundred feet in height, with the land behind it. The icebergs found along the coast afloat were from a quarter of a mile to five miles in length; their separation from the land may be effected by severe frost rending them asunder, after which the violent and frequent storms may be considered a sufficient cause to overcome the attraction which holds them to the parent mass. In their next stage they exhibit the process of decay, being found fifty or sixty miles from the land, and for the most part with their surfaces inclined at a considerable angle to the horizon. This is caused by a change in the position of the centre of gravity, arising from the abrading action of the waves.

"By our observations on the temperature of the sea, it is evident that these ice islands can be little changed by the melting process before they reach the latitude of 60°. The temperature of the sea (as observed by the vessels going to and returning from the south) showed but little change above this latitude, and no doubt it was at its maximum, as it was then the height of the summer season. During their drift to the northward, on reaching lower latitudes, and as their distance from the land increases, they are found in all stages of decay, some forming obelisks, others towers and gothic arches, and all more or less perforated; some exhibit lofty columns, with a natural bridge resting on them, of a lightness and beauty inconceivable in any other material."—*Narrative of the United States Exploring Expedition.*

The Rattler screw-propelled steam-sloop, Commander Smith, is having an altered screw fitted; the screw having proved a great drawback to her speed when under sail, a hatchway is being cut from the upper deck down into the dead-wood, by which means the screw may be lifted up so as not to impede her progress when under canvass, and may be altogether removed or replaced, if damaged, without going into dock. An extra number of millwrights were put upon her yesterday to get her out of hand as quickly as possible.

EAST INDIA COMPANY'S NAVY.

The comparative strength of the East India Company's Navy at several periods, from 1829 to the present day, will be seen from the Table here subjoined.

1829.

Elphinstone	18 guns	Sloops.
Amherst	18 „	Sloops.
Clive	18 „	Sloops.
Coote	18 „	Sloops.
Benares, 14 guns, surveying ship.		
Ternate	12 guns	Brigs.
Thetis	12 „	Brigs.
Nautilus	12 „	Brigs.
Euphrates	10 „	Brigs.
Tigris	10 „	Brigs.
Palinurus, 8 guns, surveying.		

1831.

Elphinstone	18 guns	Sloops.
Amherst	18 „	Sloops.
Clive	18 „	Sloops.
Coote	18 „	Sloops.
Benares, 14 guns, surveying ship.		
Ternate	12 guns	Brigs.
Thetis	12 „	Brigs.
Nautilus	12 „	Brigs.
Euphrates	10 „	Brigs.
Tigris	10 „	Brigs.
Palinurus	8 „	Brigs.
Royal Tiger, 4 guns, schooner.		
Hastings, 30 guns, frigate.		

STEAM VESSEL.

Hugh Lindsay.

1832.

Hastings, 30 guns, frigate.		
Elphinstone	18 guns	Sloops.
Amherst	18 „	Sloops.
Clive	18 „	Sloops.
Coote	18 „	Sloops.
Benares, 14 guns, surveying ship.		
Ternate	12 guns	Brigs.
Thetis	12 „	Brigs.
Nautilus	12 „	Brigs.
Euphrates	10 „	Brigs.
Tigris	10 „	Brigs.
Palinurus	8 „	Brigs.
Shannon, 4 guns, schooner.		
Royal Tiger, 4 guns, ditto.		

STEAM VESSEL.

Hugh Lindsay.

1839.

Hastings,* Receiving ship.		
Coote*	18 guns	Sloops.
Clive*	18 „	Sloops.
Elphinstone*	18 „	Sloops.
Tigris*	10 „	Brigs.
Euphrates*	10 „	Brigs.
Taptee*	6 „	Brigs.
Constance*	3 „	Schooners
Shannon	4 „	Schooners
Royal Tiger	4 „	Schooners
Mahi*	3 „	Schooners
Nerbudda*	2 „	Cts.
Margaret*	2 „	Cts.
Palinurus*	8 „	Brig.

STEAM VESSELS.

Atalanta.
Berenice.
Zenobia.
Victoria.
Hugh Lindsay.
Semiramis.
Euphrates .. — Iron Vessels.
Indus ...... — Iron Vessels.
Comet .... — Iron Vessels.
Meteor .... — Iron Vessels.

The Sailing Vessels marked thus * were attached to the Indian navy at the close of 1844.

List of Steam Vessels attached to the Indian Navy at the close of the Year 1844.

Name.	Tonnage.	Horse Power.	No. of Guns.	
Acbar	1143	350	6	
Auckland	946	220	4	
Sesostris	876	220	4	
Semiramis	960	300	4	
Atalanta	617	210	3	
Berenice†	664	230	3	
Cleopatra	770	220	6	
Hugh Lindsay	411	160	2	
Victoria	705	230	3	
Zenobia	684	280	2	
Indus	304	60	2	Iron Vessels.
Medusa	432	70	3	Iron Vessels.
Assyria	153	40	5	Iron Vessels.
Comet	204	40	2	Iron Vessels.
Conqueror	—	—	—	Iron Vessels.
Meteor	149	24	—	Iron Vessels.
Meance	—	—	—	Iron Vessels.
Nimrod	153	40	5	Iron Vessels.
Napier	—	—	—	Iron Vessels.
Planet	335	60	2	Iron Vessels.
Satellite	335	60	2	Iron Vessels.
Nitocris	153	40	2	Iron Vessels.

† It is understood that this vessel has been condemned, and the 'Queen,' from Bengal, put on as a packet in her room.

EVAPORATIVE POWER OF TURF, COMPARED WITH THAT OF COAL.*

The following results, as to the comparative effective power of turf and coal, are derived from the working of the Lansdowne, one of the steamers of the Inland Navigation Company which ply upon the Shannon with goods and passengers. They have been kindly placed in my hands for my present object, by Mr. C. W. Williams. Before the use of turf was introduced there was burned in a week, which comprises forty-nine hours of work, twenty-four tons of coal, which, costing on an average at Killaloe 15s. per ton, amount to 18l., or 7s. 5d. per hour. To do the same work at present, burning nothing but turf, there are consumed per week 315 boxes of turf, which, at 7d. per box, costs 9l. 12s. 7d., or 3s. 11d. per hour of work—but a shade more than half the cost with coal. The engines of the Lansdowne are condensing, of thirty-eight inches and a half diameter, and three feet and a half stroke. The usual velocity is twenty-five strokes per minute.

The box of turf contains twenty cubic feet; not very closely packed. It weighs about 3½ cwt.; so that the ton weight of turf costs about 3s. 6d. The weight of 315 boxes is hence fifty-five tons and a quarter, and the practical value of the turf is to that of the coal as 24 to 55¼, or as 43 to 100. It is interesting to consider the influence which the substitution of turf for coal in the Shannon steamers has on the population residing near its banks. In the year 1839 there was no turf burned, and the coals consumed on board the company's boats amounted to 3,108 tons. In 1843 there were burned but 724 tons of coal, although the amount of trade was much increased. The quantity of turf consumed was upwards of 7,000 tons, which, at 3s. 6d. per ton, gives an expenditure of more than 1,200l. distributed in wages of labour, by which almost the entire cost of the turf is made up. The equivalent quantity of coals would have cost above 1,800l., so that at the same time the Company saved 600l. a-year.

Those remarkable facts are well exhibited in a letter written by Mr. Williams to the Board of Admiralty, which is subjoined, as it illustrates some additional circumstances. Mr. Williams's estimate of the saving is greater than mine, for, in the preceding analysis of the results, I have taken coal at a lower price than is assumed in his letter. The reason is, that it has fallen since those results were obtained, and I have calculated from what the price is, whereas he calculated from what it was at the time quoted:—

"6, Princes Street, Cavendish Square, July 21st, 1843.

"Sir,—I have had the honour to receive your letter of the 12th instant, addressed to the Secretary of the City of Dublin Steam Packet Company, inquiring, for the information of the Lords Commissioners of the Admiralty, the proportionate duration of turf to coal in the Company's boats which ply up the Shannon from Limerick, to which I beg to give the following reply, derived from experience of the boats on that river.

"The Lansdowne, a steamer with two engines 38½ inch cylinders, at 3 ft. 6 in. stroke, consumed upon an average 120 tons of coal per month, running daily (except Sunday) a distance of forty-six miles, at 18s. per ton, covering expenses	£108	0	0
"The same duty is done with 1419 boxes of turf of twenty cubic feet, about 250 ton weight, at 7d. per box	41	7	9
Difference in the cost of the fuel per month	£66	12	3

"2. The difference in weight is, therefore, as two of turf to one of coal, and on the Shannon the difference in price is less than one-half that of coal.

"3. Its proportionate duration may be estimated by the quantity required, compared with coal to perform the same duty, that being double its weight; its duration in the furnace is half that of coal.

"4. From recent experiments with turf in the experimental boiler in the Company's yard at Liverpool, it is found that turf can only be profitably used when it is of the quality that is obtained in good seasons. If bad or damp, its evaporative power is reduced one-third and more. To improve the evaporative power of this fuel, however, results have shown that an addition of 40 per cent. of a preparation of turf by an improved method, which I have been engaged upon for some years, will render it cheaper than coal used with bad turf, or than coal burned alone; and that the same per centage of this prepared fuel added to good turf, greatly increases its evaporative power, with a very trifling addition to the cost.

"From these facts it is evident that turf may be used advantageously in localities where it abounds, and where there is an absence of coal. Care, however, must be taken that the furnace bars are lowered, not only to admit a greater bulk of fuel, but also to prevent too great a volume of air passing in the ash-pit, and then through the bars. I may add also, that in burning turf it is highly essential that air be admitted in the air chamber behind the bridge, in consequence of the rapidity with which the gases from this kind of fuel fly off. If it be excluded there upon the common furnace principle the weight and bulk of fuel will be increased, the evaporative power reduced, and the cost proportionably greater.

"It will give me much pleasure to furnish you with any further information in my power.

"I have the bonour to be, Sir, your obedient humble servant,

"To Sidney Herbert Esq., Admiralty." C. W. WILLIAMS.

I have already noticed, that from my own inquiries the best turf may be had in the turf districts for 3s. 6d. per ton, and as it is a fuel that will never be drawn far for any industrial use, we may take 4s. per ton as the practical value of turf well dried within the range of the central counties. At the price, and allowing it 44 per cent. of the calorific effect of coal, the horse power should cost 6d. per day, that is, one-fourth cheaper than coal. Mr. Williams, using the same sort of fuel as is employed at the corn mill, and paying 6d. per box, but drying it well, found that, with a large working wagon boiler there were 3·87 lb. of water evaporated per pound of turf, and that it cost 3s. 7d. to evaporate 100 cubic feet of water. Now this is at the rate of 5¼d. per horse power per working day. When the turf was burned in the furnace without Mr. Williams's peculiar mode of effecting perfect combustion, the cost per horse was 6¼d., coinciding with the result which I have derived from other sources.

From all these examples, it may be decisively concluded, that in Ireland the horse power of steam costs per day in fuel:—

Using coals, whether British or native	7¾d.
Using turf, properly dried	6d.
Using turf in Mr. Williams's mode	5¼d.

* From the "Industrial Resources of Ireland."

COLOURED DECORATIONS.

At a meeting of the Decorative Art Society, on November 26th, a paper "On Chromatic Decorations," was read by Mr. E. Cooper. He commenced with a chronological review of various modes of applying or using colour in Egypt, and on the continent of Europe, from remote times to the end of the 17th century. In referring to the stupendous and richly-decorated remains of temples and porticoes in Egypt, he commented on the dull and opaque colours, contrasted with mat and burnished gold (laid on in leaves) which are found therein, and also upon mummy cases; he described the coloured intaglios on the walls, and the painted ceilings of deep azure, studded with stars in the temple of Medeenet Haboo, at Thebes; he exhibited drawings of Egyptian ornament of excellent design, and remarked that no progressive improvement in decorative art is discernible in these works.

The temples of Greece were then noticed, where colour was applied to capitals, frieze, entablature, and the backgrounds of the tympanum; also on the ogee mouldings, where honeysuckle, egg, and other enrichments were painted or stencilled; and it was observed that, although no remains have been discovered, it was reasonable to infer, from the eminent state of plastic art, that contemporary pictorial art had arrived at considerable perfection, and the names of some Greek artists were given, on the authority of Pliny and Quintilian. After some remarks on the vases of Greece, and the mural decorations of the sepulchres of Etruria, he directed especial attention to the magnificent baths, or thermæ, of Titus, at Rome (erected A. D. 70), and (referring to the illustrations by M. Ponce), he observed that the fresco paintings found there display, in the grouping, drawing, and management of drapery, a refined feeling and knowledge of art; and in his remarks on the colour used, he observed that the decorations were executed, most probably, by Greek artists.

The decorations of Pompeii and Herculaneum, being of the same period, were then described; but, as might be supposed, from their being provincial towns, they would be found inferior in execution and splendour to those of the capital. The arrangement on the walls, of masses of black, red, and white, exhibited a principle which was commented on at some length; and it was also remarked, that these examples do not afford an absolute criterion by which to estimate the perfection of the arts of that or the preceding age. Passing over several centuries, he next noticed the early efforts of Christian art, remaining to us in the mosaics of the churches and palaces of Italy; and after some remarks on the productions of Cimabue, Giotto, and Leonardo da Vinci, he entered upon a consideration of the decorative works of Michael Angelo and Raphael.

In this period of Italian art, the anachronisms and disregard of relative proportion, in the parts composing arabesque or grotesque decorations, were especially noticed, as well as the enrichments, similarity in design and colouring, existing between the works of Raphael and his school, and those in the baths of Titus, before alluded to, and which were discovered at this time: a striking instance was exhibited, in the decorations at Mantua, by Giulio Romano, and Andrea Montagna. (See Gruner, plate 24, and plate 5 of the Baths.)

The magnificent decorations by the Venetians were next described, in which massive mouldings richly carved and gilt, divided the surface of ceilings and walls; the coffers or panels being filled with paintings by Titian, Tintoretto, &c., produced a gorgeous effect. The decorations of the ceiling of the sacristy attached to the Duomo, or cathedral at Venice were said to be worthy of recommendation, on account of durability and splendour, for open colonnades in this country (such as at the Royal Exchange); the back grounds were of vitrified gold, and exhibit all the beauty of ancient mosiac, combined with the harmonious colouring and beautiful ornament of the sixteenth century. This century witnessed the rise and decline of fine art in Italy, and in the following one, although we meet with some good artificers, they were mere copyists and mannerists, and not great artists.

In discussion, the terms arabesque, grotesque, moresque, &c., were argued; the modes of lighting, and the principles of *gravitation* of colours on walls of apartments were commented on, and a regret expressed that decorations in the houses of nobility are not sufficiently known or accessible to the inspection of decorators and artists.

BELFRY TURRETS.

No large tower can be considered complete without a staircase-turret of stone, containing an ascent by a newel stair to the bell-chamber.

This very important feature of a church tower has been singularly neglected in modern designs, in which the effect has been often much impaired, and an essential part of the construction omitted, under the idea that it is either a useless appendage, or an awkward and unsightly excrescence. Both these notions are extremely erroneous, and in urging upon architects the more general adoption of belfry turrets, we will endeavour to show that both utility and the principles of effect suggested their use to the ancient builders.

Belfry turrets are usually placed in the south-west, more rarely in the norte-west, angle of towers; they occur also in the south-east and north-east. They are polygonal, and project half externally and half internally, and have a small doorway opening into the inside. They are carried up either to the height of one or two stages, or to the belfry windows, and then weathered off with a bold and picturesque slope, or they rise above the parapet, and form a kind of castellated pinnacle turret, sometimes carrying a weathercock or other pointed termination. Very frequently they are lost in the buttresses, which are, as it were, thrust prominently outwards by a bulging swell of the masonry in one angle, readily distinguished from the rest by its visible protuberance, and by small slits to admit light and air air into the staircase within. Sometimes, as at All Saints, Paston, near Peterborough, the head of the turret merges into a broach of the spire, which gives an extremely bold and irregular effect.

There can be no doubt that irregularity gives effect to a tower, or indeed to any Gothic building. Not irregularity for irregularity's sake—that becomes affectation. But such irregularity as arises from the absence of hypocrisy, or show, or making one side the same as the other, or the like. There is no need to fear a broken or shapeless mass as the result; uniformity is far less pleasing than variety; and the eye can never be offended in Gothic buildings by a door, a window, or a buttress, being fairly pushed aside by the intervention of any necessary constructive feature.

Nothing was more fully felt by the ancient architects than this; while nothing is more cautiously and timidly adopted by modern imitators. We have seen with much pleasure, in very elaborate and splendid towers, one belfry window placed quite on one side, instead of in the middle, even though the belfry staircase which caused this remarkable irregularity was scarcely visible on the outside. Examples of this are St. John, Ryhall, and All Saints, Oakham, in Rutland. Sometimes, as at St. Wulfran, Grantham, the splendid decorated tower of which has scarcely a rival in the kingdom, one of four pinnacles is considerably larger and higher than the other three, because it forms a capping to a staircase turret. Yet who shall be bold to say this is a fault? We would say, by all means break up monotony and sameness of sides by some such expedient; and a belfry turret seems most admirably adapted to produce almost any kind of bold picturesque effect. From a distance, the lights and shadows, the peaks and the broken lines, are vastly imposing and arresting to the eye. On a near view, the bold abutment of an angle seems at once to flank and to prop the stages of a lofty tower; and on every point whence the effect is visible, the mind is gratified by the idea of ingenuity or pleased by the suggestion of necessity made subservient to decorative effect.

Some belfry turrets are corbelled off a little above the ground externally. This, though not a material difference of construction, is to be deprecated, because the tower is apt to appear overbalanced by an excrescence which emerges from the wall itself, and does not rest upon its own basis on the ground. We have seen (as in St. Peter, Barton, near Cambridge) the south-west angle singularly prolonged into a wedge-like form from the internal formation of a belfry tower; and again, we have noticed the most beautiful forms and enlargements of buttresses to give scope for the staircase.

It is true that many ancient towers were ascended by ladders, and in a few we have seen wooden stairs inclosed in wattled or boarded turrets constructed in the interior. The ascent to the floor on which the bell-ringers assemble, if above the ground, should be the belfry turret; though we may here repeat what we have often urged before, that the entrance to it should never be from without, independently of any other communication with the interior of the church.

Modern architects are generally compelled to construct a staircase in their towers; but then they strive to hide rather than boldly to display it externally; and herein consists their error. We are inclined to prefer those belfry turrets of which three or four sides project externally, sometimes even in the middle of the north or south side, and are weathered off at the upper or belfry stage, to those which are only partially developed from the outside. The attention, however, of architects needs only to be directed to the subject, and their observation will abundantly supply fit models and devices for imitation.—*Ecclesiologist.*

LIGHTNING RODS.—In a recent communication in the New Haven Courier, respecting some recent instances of houses being struck by lightning, Professor Silliman states that the lightning rods cannot be relied upon unless they reach the earth, where it is permanently wet, even in times of the severest drought; and that the best security is afforded by carrying the rod or some good metallic conductor, duly connected with it, to the water in the well, or to some other water that never fails. Professor Silliman's house, it seems, was struck; but his lightning rods were not more than two or three inches in the ground, and were therefore virtually of no avail in protecting the house. He states that his confidence in the efficiency of rods is in no degree diminished.—'New York Observer.'

SYNOPSIS OF RAILWAYS INCORPORATED IN 1845, WITH THEIR ALLIANCES.

[For the following important paper we are indebted to the indefatigable and well directed exertions of an old correspondent, who under the signature O. T., has contributed several invaluable papers to this Journal.

In the formation of the following synopsis, the Supplement of the "Times," Nov. 17, 1845, the Railway Almanac and Directory for 1846, the Companion to the British Almanac for 1846, the Railway Shareholders' Manual, by Henry Tuck, 6th edition, and two Parliamentary Returns, dated July 17th and August 4th, have been consulted. None, however, of these authorities give the alliances of the new lines which are here added. The parliamentary return of August 4th, 1845, which is important, as it gives the number of shares subscribed for, as well as the number of shares empowered to be created, which shows the statistics of each line in public opinion, and the means of the directors in controlling the market by gradually selling shares where the number authorized exceeds the number subscribed for.]

1. *Irish Great Western.*

20,000 shares of 50*l.* each; capital 1,000,000*l.*

From Dublin to Mullingar, connecting the Valley of the Shannon with the Irish capital. To commence in connection with the Dublin and Cashel line, near Luccan, passing near the towns of Leixslip, Celbridge, Maynooth, Kilcock, Clonard, Kinnegar, and Kilnear, to Mullingar, and thence by Meale to Athloue.

Length of line 77 miles, 2 furlongs, 4 chains. Reported against by the Board of Trade. Capital subscribed, 903,000*l.* and 18,060 shares. Estimated cost, 986,651*l.* Power to borrow on loan 333,000*l.* Embodied in group Z, and recommended by the committee.

Working expenses estimated at 40 per cent. Royal Assent July 21. Sir John M'Neil engineer.

2. *Londonderry and Coleraine.*

10,000 shares, of 50*l.* each; capital 500,000*l.*

To commence at Londonderry, passing the border of Lough Foyle, and terminating at Coleraine, with a branch to Newtown. Length of main line and branch, 38 miles, 6 furlongs, 3 chains. Amount subscribed, 380,000*l.* Power to borrow 166,666*l.* Reported against by the Board of Trade. Considered by committee of group S, and recommended. Working expenses 14,000*l.* per annum. Royal Assent August 4. Charles Lanyon, engineer.

3. *Belfast and Ballymena.*

7,700 shares of 50*l.* each; capital 385,000*l.*

From the former to the latter place, with a branch to Carrickfergus. Deposit 2*l.* 10*s.* per share. Amount of deposits 19,250*l.* Total length of the line 37 miles, 7 furlongs. Power to borrow 128,333*l.* Recommended by the Board of Trade, and recommended by the committee of group S. Single line. Estimate of working expenses 11,000*l.* Royal Assent, June 21. Charles Lanyon, engineer.

4. *Dublin and Belfast Junction (and Navan Branch).*

19,000 shares of 50*l.* each; capital 950,000*l.*

Deposit 2*l.* 10*s.* per share. Amount of deposit 47,500*l.* Total length of the line, from Drogheda to Portadown, 73 miles, 4 furlongs, 8 chains. Estimate 950,733*l.* Power to borrow 316,665*l.* Recommended by Board of Trade; also by committee of group R. Branch to Kells. Working expenses 40 per cent. Royal Assent July 21. Engineer Sir John M'Neil. Meeting August 20. Miles Reck, Secretary. Office, 2, Talbot-street, Dublin. Call September 10, 2*l.* 10*s.* Proposed Great County Down company are to inspect a trial section of the line to Hillsborough.

5. *Dundalk and Enniskillen.*

15,000 shares of 50*l.* each; capital 750,000*l.*

Deposit 2*l.* 10*s.* Amount of deposit 37,500*l.* Total length of the line, including branch to Monaghan, 40 miles, 6 furlongs. Estimated expenses 450,000*l.* Power to borrow 250,000*l.* Recommended by the Board, also by committee of group R. Working expenses 30 per cent. Royal Assent July 21. Engineer Sir John M'Neil. Register of scrip Oct. 18, 1845. Hatfield Nicholson, secretary. Office 72, Talbot-street, Dublin. Company operates and in conjunction with Dublin and Drogheda as Belfast Junction and Irish North Midland.

6. *Cork and Bandon.*

4,800 shares of 50*l.* each; capital 240,000*l.*

To connect the towns of Bantry, Bandon, Kinsale, Berehaven, and Castletown with a rich agricultural and mineral district and the city and harbour of Cork. Length of Line 20 miles. Power to borrow 80,000*l.* Subscribed 200,000*l.* in 4,000 shares. Recommended by the Board of Trade, and by committee of group XX. Working expenses 40 per cent. Royal Assent July 21. Engineers Messrs. Sealey. Secretary J. M'Donnell.

7. *Great Southern and Western.*

24,000 shares of 50*l.* each; capital 1,200,000*l.*

Extension to Limerick and Cork. The extension to Cork will commence between Holycross and Cashel, in conjunction with the Great Southern and Western line, and pass near the towns of Tipperary, Kilmallock, Charleville, and Mallow. The extension to Limerick leaves the main line near Tipperary, passing the towns of Pallas Green, and Cahirconlish. Length of line 98 miles. Subscribed 1,184,100*l.* Power to borrow 400,000*l.* Recommended by the Board of Trade, and committee on group AA. Working expenses 40 per cent. Royal Assent July 21. Engineer Sir J. M'Neil. Subscribed to Irish Great Western (Dublin and Galway) 800,000*l.* to Wexford, Carlow, and Dublin Junction 100,000*l.* to Killarney Junction 20,000*l.* Also new line proposed, Clonmel, Cashel, Templemore, Nenagh, Borris in Ossary, to Roscrea, Parsonstown, Ennis, Killaloe, and Waterford and Kilkenny, for which an Act is obtained. Mr. Taylor, secretary.

8. *Waterford and Limerick.*

15,000 shares of 50*l.* each; capital 750,000*l.*

To commence at the city of Waterford, proceeding through the towns of Carrick-on-Suir, Clonmel, Cahir, and Tipperary to Limerick, affording accommodation to a population of more than a million, and giving to a rich agricultural district an excellent port for the shipment of produce to England. Length of line 77 miles, 7 feet. Subscribed 590,300*l.* in 118,068 shares. Power to borrow 250,000*l.* Recommended by the Board of Trade, and committee of group AA. Working expenses 40 per cent. Royal Assent July 21.

9. *Newry and Enniskillen.*

18,005 shares of 50*l.* each; capital 900,000*l.*

To commence, in junction with the Dublin and Belfast Junction, at Newry, passing through the towns of Monaghan, Clones, and Enniskillen, terminating, in junction with the Ulster railway, at Armagh. Length of line 75 miles, 5 furlongs. Capital subscribed 14,210*l.* in 284 shares. Estimate 833,847*l.* Power to borrow 300,000*l.* Recommended by the Board of Trade, and by committee of group R. Working expenses 33½ per cent. Royal Assent July 21. Engineer Sir JohnRennie. Mr. Saunders secretary.

10. *Waterford and Kilkenny.*

12,500 shares of 20*l.* each; capital 250,000*l.*

On this line the wooden rail is to be used as a substitute for iron. The wood is to be prepared by Payne's process, and the engines and carriages are to be fitted with Prosser's guide wheels. Length of line 37 miles, 3 furlongs. Subscribed capital 200 000*l.* in 10,000 shares. Power to borrow 83,000*l.* Recommended by the Board of Trade, also by the committee of group BB. Working expenses 40 per cent. Royal Assent July 21. J. Valentine, Engineer. Office, 34, Broad-street-buildings, London. Thos. Prosser, secretary.

11. *Londonderry and Enniskillen.*

10,000 shares of 50*l.* each; capital 500,000*l.*

Commencing at Londonderry, and passing through Carrigans, St. Johnston, Strabane, Clifford, Newtownstewart, Dromore, Trellick, to Enniskillen, in junction with the line to Dundalk, thus forming a direct communication between the north-west of Ireland and Dublin, and the east coast. Length of line 56 miles, 1 furlong, 4 chains. Estimate 462,123*l.* Subscribed 380,000*l.* in 7,600 shares. Power to borrow 166,666*l.* Working expenses 40 per cent. Royal Assent July 21. Sir John M'Neil. Engineer. Register of scrip 21 Oct. Fred. H. Hemming, secretary, Moorgate-street chambers, London.

12. *Dublin and Drogheda.*

Capital 150,000*l.*

Howth extension. Length 3 miles, 5 furlongs, 4½ chains. Estimated expense 40,000*l.* Power to borrow 50,000*l.* Working expense 30 per cent. Royal Assent July 21. Engineer Sir J. M'Neil.

13. *Ulster Extension.*

Estimate 133,035*l.*

From Portadown to Armagh. It was originally intended to run the Ulster line from Belfast to Armagh, and capital was taken for that purpose, so that it will not be requisite to issue any new shares. A thirteenth call for 2*l.* 10*s.* has just been made. This will make the amount paid up on 32*l.* on shares of 50*l.* Length of line 11 miles, 4 furlongs. Working estimate 33 per cent. Royal Assent July 21. Godwin, Engineer. Raised 50,000*l.* on loan, and it is proposed to take interest. Newry, Banbridge, and Belfast Junction; the engineer to survey the country between Newry, Moira, and Lisburn, as also Loughbrickland, Dromore, and Hillsborough.

14. *Leeds and Thirsk.*

To commence at Leeds, and terminate at Thirsk, passing through the most populous part of the West Riding of Yorkshire. Length 46 miles, 1 furlong, 1 chain. Amount subscribed 863,100*l.* in 17,362 shares. Power to borrow 299,000*l.* Reported against by the Board of Trade, and recommended by committee of group B. Working expenses 40 per cent. Royal Assent July 21. J. Grainger, engineer. Payne, Eddison, and Ford, solicitors. Office, 58, Albion-street, Leeds. Proposed extension through the Valleys of Wharfe to Skipton and the Nidd to Pateley, also to the north-east to Stockton.

15. *Leeds, Dewsbury, and Manchester Junction.*

13,000 shares of 50*l.* each; capital 650,000*l.*

To commence at Leeds in junction with the Leeds and Bradford, passing through Dewsbury, towards Huddersfield, and terminating, in junction with the Manchester and Leeds, half a mile west of Dewsbury station. Length of line 20 miles, 3 furlongs, 5 chains. Estimated expense 626,000*l.* Power to borrow 167,000*l.* No report from Board of Trade. Recommended by committee of group B. Working expenses 35 per cent. Royal Assent June 30. Messrs. Grainger and Miller, solicitors. Office of the company, Leeds. Wm. Eagle Bott, secretary. 5*l.* call 23 Oct. Interest paid Feb. and August.

16. *Shrewsbury, Oswestry, and Chester Junction.*

20,500 shares of 20*l.* each; capital 410,000*l.*

Will form a continuation of the North Wales Mineral railway, and will complete the direct line of railway from Chester to Shrewsbury. Length of line 23 miles, 5 furlongs. Estimate, 371,000*l.* Power to borrow 130,000*l.* No report from the Board of Trade. Recommended by committee of group Q. Working expenses 50 per cent. Royal Assent June 30. H. Robertson, engineer. Amalgamated with North Wales Mineral railway, allowing to the latter company for 20*l.* shares 26*l.* 13*s.* 4*d.* stock, and for 10*l.* shares 14*l.* 6*s.* 8*d.* and issuing new 10*l.* stock for extension, one for each 20*l.*, and one for two 10*l.* North Wales Mineral railway.

17. *Ely and Huntingdon.*

10,800 shares of 25*l.* each; capital 194,400*l.*

To commence at Ely, in junction with the Eastern Counties and Lynn and Ely railway, passing through St. Ive's, Huntingdon, and St. Neot's, to Bedford. Length of line 22 miles, 6 chains. 87,298 shares; subscribed a capital of 157,125*l.* Estimate, 190,046*l.* Power to borrow 64,800*l.* No report from the Board of Trade. Recommended by committee of group I. Working expenses 30 per cent. Royal Assent June 30. J. U. Rastrick, engineer. Call of 3*l.* 18*s.* Oct. 1. Offices, Lynn, Norfolk. Secretary, W. W. Williams.

18. *Gravesend and Rochester (Thames Medway).*

6,000 shares of 20*l.* each; capital 85,000*l.*

To commence between the Town and Terrace Piers, through the Terrace Gardens and grounds of the Fort, over the lands adjoining the Marshes, under Gad's Hill, crossing the Medway, near Rochester bridge, and terminating at the Gibralter Inn, Chatham. Length of line 6 miles, 7 furlongs, 1 chain. Amount of capital subscribed 127,500*l.* Estimate 170,000*l.* Power to borrow 56,666*l.* No report from the Board of Trade. Recommended by committee of group A. Royal Assent July 31. Extension ½ mile. J. U. Rastrick, engineer.

19. *Preston and Wyre Branches.*

12,000 shares of 20*l.* each; capital 100,000*l.*

To commence at Preston, in junction with the Preston and Wyre, passing through the populous manufacturing district of Over Darwen, terminating, in junction with the Blackburn, Bolton, and Darwen railway at Lower Darwen. Length of line 8 miles 2 furlongs, 6 chains. Estimate 50,000*l.* Power to borrow 33,333*l.* No report from the Board of Trade, and recommended by committee of group HH., as Lytham Branch, and Blackpool Branch. Working expenses 32 per cent. Royal Assent July 21. G. P. Bidder, engineer.

20. *North Wales.*

12,000 shares of 25*l.* each; capital 300,000*l.*—Amalgamated.

To commence at Bangor, in junction with the Holyhead and Chester railway, passing through the slate districts of Caernarvonshire and Snowdon, and terminating at Port Dynllaen. Length of line 45 miles. 10,620 shares. Subscribed, a capital of 265,000*l.* Power to borrow 100,000*l.* Working expenses 40 per cent. Royal Assent July 21. Sir John Rennie, engineer. Negotiating with Chester and Holyhead Railway.

21. *Brighton and Chichester (Portsmouth Extension).*

6,000 shares of 50*l.* each; capital 320,000*l.*—Amalgamated.

From the Rope-walk, Chichester, to St. James's-road, Portsea, with a branch commencing at the Farlington Waterworks to the Gosport branch of the London and South Western railway. Length of line 22 miles. Reported against by the Board of Trade. Single line, Royal Assent August 8. J. U. Rastrick, engineer. Mr. Ottley, secretary. Office, Dean-street. The above shares issued and sold to the Brighton Railway Company.

22. *Oxford, Worcester, and Wolverhampton.*

30,000 shares of 50*l.* each; capital 1,500,000*l.*

To commence at Wolverhampton, diverging from the Grand Junction, passing through the districts in the vicinity of Bilston, Tipton, Dudley, Stourbridge, Kidderminster, Stourport, Droitwich, Worcester, Pershore, Evesham, Moreton, and Oxford, in junction with the Great Western railway. Leased in perpetuity to the Great Western railway at 3½ per cent. on 22,500*l.*, and capital 1,125,000*l.* Authorised loan, 500,000*l.* Working expenses, 40 per cent. Royal Assent August 4. Brunel, engineer. N. T. Smith, secretary, Worcester. This Company have bought Stratford and Moreton railway, Stratford-upon-Avon and Stourbridge (extension) canals, and have shares in projected Cheltenham, Oxford, and South Staffordshire railway.

23. *Oxford and Rugby.*

12,000 shares of 50*l.* each; capital 600,000*l.*

In junction with the Great Western railway at Oxford, passing through Woodstock, Banbury, and Southero, and terminating at Rugby, in junction with the Midland and Birmingham railway. 7 feet gauge. Length 50 miles, 4 furlongs, 6 chains. Number of shares subscribed for 9,000, and capital 450,000*l.* Authorised loan, 200,000*l.* Estimated expenses, 700,000*l.* Working expenses, 40 per cent. Royal Assent, Aug. 4.

24. *Glasgow, Barrhead, and Neilston Direct.*

6,000 shares; capital 150,000*l.*

Length of line 8 miles, 7 furlongs, 8 chains. Capital 150,000*l.* Estimated expenses, 142 000*l.* Authorised loan, 50 000*l.* Number of shares subscribed for, 5,142*l.* Capital 128,550*l.* Working expenses, 45 per cent. Royal Assent June 30. N. Robson, engineer.

25. *Liverpool and Manchester Extension.*

Capital 805,000*l.*

Estimated expense, 804,000*l.* Authorised loan, 268,333*l.* Working expenses 40 per cent. Royal Assent July 61. Chas. Liddle, engineer.

26. *Eastern Counties Extension.*

Estimated expense. Ely and Whittlesea deviation, 320,000*l.*; also Cambridge and Huntingdon line; estimated expenses, 150,000*l.* Capital stock 150,000*l.* Authorised loan 50,000*l.* Length of line 17 miles, 4 furlongs, 5 chains. Amount of capital subscribed, 113,000*l.* The Company do not raise any money by loan on shares for the Whittlesea deviation line. Royal Assent July 21. M. E. Borthwick, engineer. Royal Assent (Cambridge) August 8. R. Stephenson, engineer.

27. *York and North Midland Extension..*

York and Scarborough Deviation line. Estimated expense, 38,250*l.* of Bridlington branch, 87,000*l.*; and of Harrogate branch, 230,000*l.* Length of branch to Bridlington, 19 miles, 6 furlongs, 3 chains, and amount of capital subscribed 70,000*l*, with power to borrow 29,000*l.* Length of Harrogate branch, 18 miles, 2 furlongs, 4 chains. Amount of capital subscribed, 180,000*l.*, with power to borrow 76,666*l.* Working expenses, 33 per cent. Royal Assent, July 21. J. C. Birkenshaw, engineer. Wm. Gray, jun., secretary.

28. *South Eastern Extension.*

From the Tonbridge station of the South Eastern railway. Length of line 5 miles, 1 furlongs, 3 chains. Amount of capital subscribed, 135,000*l*, with power to borrow 60,000*l.* Company also obtained power to borrow 47,560*l.* for widening and extension of the London and Greenwich, which was estimated at 66,500*l.* and an increase of their capital of 142,700*l.*; for that purpose also an increase of 180,000*l* for the line from Tonbridge to Tonbridge Wells; as also an increase of 187,000*l.* with power to borrow 62,000*l.* for branch to Deal, and extension of the South-Eastern railway to Canterbury, Ramsgate, and Margate. Wm. Cubitt, engineer. Royal Assent Aug. 4, Aug 8, July 31.

29. *Leeds, Dewsbury, and Manchester Junction.*

13,000 shares; capital 650,000*l.*

A line from Leeds, joining the Leeds and Bradford, through Dewsbury to Huddersfield, joining the Leeds and Manchester at Kirkheaton, with branch to Mirfield and Birstall. Length of line 20 miles, 3 furlongs, 5 chains. Estimated expense, 626,000*l.* Authorised loan, 166,000*l.* Number of shares subscribed for, 2,737. Capital, 487,850*l.* Reported against by the Board of Trade, and recommended by committee of group B Working expenses, 35 per cent. Royal Assent, June 30. Messrs. Grainger and Miller, engineers. 5th call, Oct. 23. Interest paid, 4 per cent. Feb. and Aug. William Eagle Bott, secretary, Leeds.

30. *Exeter and Crediton.*

2,800 shares; capital 70,000*l.*—Amalgamation.

To commence at Crediton, and terminate, in junction with the Bristol and Exeter railway, at Cowley Bridge. Length of line 5 miles, 6 furlongs. The whole of the shares subscribed for, with a capital of 70,000*l.* Authorised loan, 23,333*l.* Recommended to be postponed by the Board of Trade, and recommended by the committee of group M, which sat only one day. Royal Assent, Aug. 9. R. Dimond, engineer. Thomas Hactmate, secretary, Exeter. Leased to Great Western at 3,000*l.* per annum, and one-third of receipts if above 7,000*l.* per annum.

31. *Lynn and Dereham.*

10,800 shares; capital 270,000*l.*

Commences at the terminus of the Lynn and Ely line, and proceeds, by way of Swaffham, to East Dereham, in junction with a line to Norwich. Length of line, 20 miles, 5 furlongs, 1 chain. Number of shares subscribed for, 10,510, with a capital of 262,750*l.* Authorised loan, 90,000*l.* Estimated expense, 270,000*l.* Recommended to be postponed by the Board of Trade, and recommended by the committee of group K to be adopted. Working expenses, 35 per cent. Royal Assent, July 31. J. U. Rastrick, engineer. Call of 3*l.* 12*s.* 6*d.* October 1st. Office, Lynn. Secretary, W. W. Williams.

32. *Wilts, Somerset, and Weymouth.*

30,000 shares of 50*l.* each; capital 1,500,000*l.*

To commence, in junction with the Great Western railway, at Corsham, passing through the towns of Melksham, Trowbridge and Westbury, with branches to Devizes and Bradford. The line passes through Warminster, and the Valley of the Wiley, to Wilton and Salisbury, and the other diverges to Frome, Bruton, Castle Cary, Yeovil, Dorchester, Weymouth, and Bridport. Guaranteed 4 per cent. by the Great Western railway. Length of line, 33 miles, 2 furlongs, 6 chains. Number of shares subscribed, 23,046, and capital, 1,152,300*l.* Authorised loan, 500,000*l.* Estimated expenses, 1,500,000*l.* Board of Trade reported in favour, and committee of group G confirmed their report. Working expenses 40 per cent. Royal Assent, June 30. I. K. Brunel, engineer. Leased to the Great Western at 4 per cent., and ½ per cent. increase, should the Great Western railway pay 8 per cent. Interest paid, June 30, Dec. 31. Propose to alter the line, and extend it to Salisbury, with the consent of the South Western company.

33. *Southampton and Dorchester.*

10,000 shares of 50*l.* each; capital 500,000*l.*

From the former to the latter place, by way of Redbridge, Brockenhurst, Burley, Ringwood, Wimbourne, Hanworthy, and Wareham. Length of line, 62 miles. Number of shares subscribed for, 7,625, and capital, 381,260*l.* Authorised loan, 166,666*l.* Estimated expense, 500,000*l.* Recommended by the Board of Trade, also by committee of group G. Single line. Working expenses, 40 per cent. Royal Assent, July 21. Captain Moorsom, engineer.

34. *Guildford, Chichester, and Portsmouth.*

20,000 shares of 50*l.* each; capital 500,000*l.*

Commences at Guildford, in junction with the Guildford and Woking line, passing through Godalming to Chichester, in junction with the Brighton and Chichester line; thence, through Emsworth and Havant, to Portsmouth and Fareham, terminating in junction with the South Western line. To be leased by the South Western railway, and guaranteed 4 per cent. on the outlay. Estimated expense, 350,000*l.* Authorised loan, 166,900*l.* Length of line, 60 miles. Recommended by the Board of Trade, and committee of group L. Working expenses, 93,000*l.* per annum. Royal Assent, July 21. J. Locke, engineer. Purchased by South Western, also Fareham Branch.

35. *Newcastle and Berwick on-Tweed.*

56,000 shares of 25*l.* each; capital 1,400,000*l.*

Commences in junction with North British line at Castle Hill, Berwick-on-Tweed, and terminates, in junction with Bradley junction line, in Gateshead, with a branch to Neville-street, to join the Newcastle and Carlisle line, and a branch, 7 miles, to Blyth, and one 5 miles, to Alnwick. Length of line, 95 miles, 3 furlongs. Number of shares subscribed for, 39,725, and capital, 993,125*l.* Authorised loan, 466,666*l.* Estimated expense, 1,400,000*l.* Recommended by the Board of Trade, and committee of group E. Working expenses, 40 per cent. Royal Assent, July 31. R. Stephenson, engineer. J. Close, secretary.

36. *Richmond, Surrey, and West End Junction.*

13,000 shares of 20*l.* each; capital 260,000*l.*

To commence at Richmond, and terminate at a junction with the South Western, at Falcon Lane, Battersea, passing thus the districts of Wandsworth, Putney, Barnes, and Mortlake. Length of line, 6 miles. Number of shares subscribed, 8,715. Capital, 164,300*l.* Authorised loan, 86,000*l.* Estimated expense, 200,000*l.* Recommended by the Board of Trade, as also by the committee of group LL. Royal Assent, July 21. J Locke, engineer. Secretary, Richard Meade. Office, 3, Moorgate-street. Call of 4*l.* Aug. 30.

37. *Lynn and Ely.*

12,000 shares of 25*l.* each; capital 300,000*l.*

From King's Lynn to the city of Ely, meeting there the Northern and Eastern line and its extension to Norwich and Peterborough. Length of line, 37 miles, 5 furlongs, 6 chains. Number of shares subscribed for, 11,629. Capital, 290,720*l.* Authorised loan, 100,000*l.* Estimated expense, 300,000*l.* Recommended by the Board of Trade, and committee of group I. Branch to Wisbeach. Working expenses, 13,433*l.* Royal Assent, June 30. J. U. Rastrick, engineer. Call of 2*l.* 10*s.* Oct. 1. Office, Lynn. Secretary, W. W. Williams.

38. *Trent Valley.*

62,500 shares of 20*l.* each; capital 1,250,000*l.*

Commences at Rugby, passing through Nuneaton, Atherstone, Tamworth, Lichfield, and terminates, in junction with the Grand Junction line, at Castle Church. Length of line, 49 miles, 3 furlongs, 4 chains. Number of shares subscribed for, 57,442. Capital, 1,148,840*l.* Authorised loan, 417,666*l.* Estimated expense, 900,000*l.* Recommended by the Board of Trade, also the committee of group O. When complete, to be leased in perpetuity to the London and Birmingham railway, guaranteeing the same dividend as their own line. Working expenses, 40 per cent. Royal Assent, July 21. T. J. Gooch, engineer. Secretary, E. J. Cleather. Office, 68, George-street, Manchester. Registered, Aug. 21. Meeting, 20 Sept. Subscribed 306,000*l.* towards the North Staffordshire.

39. *South Wales.*

56,000 shares; capital 2,800,000*l.*

Commences at a junction with the Cheltenham and Great Western railway, at Gloucester, crossing the Severn, through the Forest of Dean, by Monmouth to Chepstow, Newport, and Cardiff; thence to Cowbridge, Bridgend, Port Cawl, Neath, Swansea, and Caermarthen, terminating in two branches, one to Pembroke and the harbour of Milford Haven, the other to Fishguard. Length of line, 183 miles, 4 chains. Number of shares subscribed for, 42,000. Capital, 2,100,000*l.* Authorised loan, 233,333*l.* Estimated expense, 2,500,000*l.* Recommended by the Board of Trade, also by the committee of group P. Leased to the Great Western railway. Working expenses, 40 per cent. Royal Assent, Aug. 4. Brunel, engineer. Secretary, N. Armstrong. Office, 499, West Strand, London. Register of scrip, Sept. 8. Meeting, 31 Oct. The Glamorgan Central Mineral, late Daffryn, Llysard, and Port Cawl, have resolved to unite with this company.

40. *Monmouth and Hereford.*

11,000 shares; capital 350,000*l.*

Length of line, 36 miles, 2 feet, 8 chains. Number of shares subscribed for, 8,250. Capital, 412,500*l.* Authorised loan, 183,333*l.* Estimate of expense, 550,000*l.* Recommended by the Board of Trade, also committee of group P. Working expenses, 40 per cent. Royal Assent, Aug. 4. Brunel, engineer.

41. *Blackburn, Darwen, and Bolton.*

12,000 half shares of 50*l.* each; capital 300,000*l.*

To connect the towns of Blackburn, Darwen, and Turton with Bolton, by which a railway communication will be established with Manchester. Length of line, 14 miles. Estimated expense, 300,000*l.* Authorised loan, 100,000*l.* Recommended by the Board of Trade, and committee of group D. Working expenses, 40 per cent. Royal Assent, June 30. J. Watson, engineer. F. H. James, secretary. Office, King-street, Blackburn. Registered Aug. 20.

42. *Blackburn, Burnley, Accrington, and Colne Extension.*

21,200 shares of 25*l.* each; capital 530,000*l.*

Commences, in junction with the Manchester, Bury, and Rossendale line, near Haslingden, connecting the populous towns of Blackburn, Burnley, Accrington, Clitheroe, Colne, and Whalley with the town of Manchester. Length of line, 24 miles, 7 chains; number of shares subscribed for, 19,013, and capital, 475,325*l.*; authorised loan, 176,666*l*; recommended by the Board of Trade, and committee of group D; working expenses, 40 per cent.; royal assent, June 30; — Collister, engineer; registered 19th July; James Smithers, secretary, Market-street, Bury.

43. *Whitehaven and Furness.*

17,500 shares of 20*l.* each; deposit 1*l.*; capital 350,000*l.*

Commences, in junction with the Furness railway, in North Lancashire, now in progress of formation, and eventually to extend, by way of Ulverstone, to Lancaster. Length of line, 34 miles, 8 chains; number of shares subscribed for, 14,237; and capital, 284,740*l.*; authorised loan, 116,000*l.*; estimated expense, 350,000*l.*; recommended by the Board of Trade, also by committee of group II; single line; working expenses, 11,392*l.* per annum; royal assent, July 21; J. Stephens, engineer; John Meyer, secretary, 1, Guildhall-chambers, Basinghall-street, London; call of 3*l.* 20th Oct.; proposed extension of line to Ulverstone and to Lancaster, 25 miles, at an estimate of 750,000*l.* for which the stock is issued.

44. *Caledonian.*

42,000 shares of 50*l.* each; capital 2,100,000*l.*

Commences at Carlisle, junction with Lancaster and Carlisle, passing through Lanarkshire and Dumfriesshire, and terminating, in junction with the Edinburgh and Glasgow railway. Length of line, 137 miles, 2 furlongs, 5 chains. Number of shares subscribed, 34,460*l.*; capital, 1,723,000*l.*; authorised loan, 700,000*l.*; estimate, 2,100,000*l.*; recommended by the Board of Trade, and the committee of group DD; working expenses, 47 per cent.; royal assent, July 31; J. Locke, and J. E. Errington, engineers; secretary, D. Rankine; office, 122, Princes-street, Edinburgh; registered 1st October.

45. *Scottish Central.*

34,000 shares of 25*l.* each; capital 850,000*l.*

Length of line, 47 miles, 3 furlongs, 3 chains; number of shares subscribed for, 26,311; and capital, 657,775*l.*; authorised loan, 283,330*l.*; estimated expense, 850,000*l.*; recommended by the Board of Trade, and committee of group DD; working expenses, 40 per cent.; royal assent, July 31; Messrs. Locke and Errington, engineer; secretary, Robert D. Ker; office, 34, St. John-street, Perth; registered, 20th Aug.; Leased to Edinburgh and Glasgow at 6 per cent.

46. *Aberdeen.*

16,600 shares of 20*l.* each; capital 830,000*l.*

Connects the city of Aberdeen with the towns of Stonehaven, Montrose, Brechin, Arbroath, Forfar, Dundee, Perth, Stirling, Edinburgh and Glasgow. Length of line, 51 miles; number of shares subscribed for, 12,925*l.*; and capital, 646,250*l.*; authorised loan, 276,666*l.*; estimated expenses, 830,000*l.*; recommended by the Board of Trade, and committee of group EE; working expenses, 33 per cent.; royal assent, July 31; Cubitt, engineer; Geo. Keith, secretary, 83, Union-street, Aberdeen; call of 2*l.* 10*s.* Nov. 1; amalgamated with the proposed Great North of Scotland.

47. *Clydesdale Junction.*

6,666 shares of 50*l.* each; capital 330,000*l.*

Commences at Glasgow termini of railways, and passes through the Valley of the Clyde, and near the towns of Hamilton, Bothwell, Motherwell, and Wishawton. Length of line, 15 miles, 2 feet, chains; number of shares subscribed for, 4,393; and capital, 219,650*l.*; authorised loan, 110,000*l.*; estimate of expense, 290,000*l.*; recommended by the Board of Trade, and by committee of group DD; working expenses, 40 per cent.; royal assent, July 31; J. Locke, and J. E. Errington, engineers; secretary, Alexander Grahame, 124, St. Vincent-st., Glasgow; registered, Aug. 27; amalgamated with the Caledonian at par, and guaranteed 6 per cent.; with division of profits; brought Pollock and Govan railway for 120,000*l.*

48. *Edinburgh and Northern.*

26,000 shares of 25*l.* each; capital 650,000.

From Edinburgh, through Fife, to Dundee. Length of line, 41 miles, 7 feet; number of shares subscribed for, 19,830; and capital, 495,750*l.*; authorized loans, 216,666*l.*; estimated expense, 650,000*l.*; recommended by the Board of Trade, and committee of group FF; single line; working expenses, 30 per cent.; royal assent, July 31; T. Grainger, engineer; The Company propose various extension, and have issued new shares, 26,000, of 15*l.* each, and allotted one to two old, and one to every three of Newport; extension shares of 15*l.* previously issued; secretary, Mr. Henry Lees, 4, St. Andrew-square, Edinburgh.

49. *Glasgow, Barrhead, and Neilston Direct.*

6,000 shares of 25*l.* each; capital 150,000*l.*

Length of line, 8 miles, 7 feet, 8 chains; to form a direct line of communication; number of shares subscribed for, 5,142*l.*; capital, 128,550*l.*; authorised loan, 50,000*l.*; estimate of expense, 142,500*l.*; recommended by the Board of Trade, and committee of group GG; working expenses, 45 per cent.; royal assent, June 30; Neil Robson, engineer; meeting Sept. 30; the Glasgow and Greenock railway work the line, the toll arranged with Glasgow, Kilmarnock, and Ardrossan company.

50. *Scottish Midland Junction.*

12,000 shares of 25*l.* each; capital 300,000*l.*

Passes through the Valley of Strathmore, and will form a link of communication between the Scottish Central railway at Perth and the Arbroath and Forfar and Aberdeen railways. Length of line, 33 miles, 2 furlongs, 2 chains; number of shares subscribed for, 10,740; and capital 268,100*l.*; authorised loan, 100,000*l.*; estimated expense, 300,000*l.*; recommended by the Board of Trade, and committee of group EE; working expenses, 40 per cent.; royal assent, July 31; Messrs. Locke and Errington, engineers.

51. *Dundee and Perth.*

18,000 shares of 25*l.* each; capital 200,000*l.*

Joins the Dundee and Arbroath line, and is 20 miles, 5 feet, 8 inches in length; number of shares subscribed for, 7,899; capital, 147,475*l.*; authorised loan, 66,600*l.*; estimate of expense, 200,000*l.*; recommended by the Board of Trade, and committee of group EE; working expenses, 33 per cent.; royal assent, July 31; J. Miller, engineer. The Company have agreed to lease the line in perpetuity the Dundee and Newtyle, guarantee 1 per cent. upon a capital stock of 115,000*l.* and issue new stock for a new company, the Dundee andStrathmore Junction, who are to have 6 per cent. dividend, the Newtyle subsequently to participate.

52. *Kendal and Windermere.*

5,000 shares of 25*l.* each; capital 125,000*l.*

In junction with the Lancaster ond Carlisle line, at Kendal, terminating at Windermere, and the Lakes. Length of line, 10 miles, 2 furlongs, 4 chains.; number of shares subscribed for, 152; and capital, 3,821*l.*; authorised loan, 40,000*l*,; estimated expense, 125,000*l.*; recommended by the Board of Trade, and committee of group II; royal assent, June 30; John Harris, engineer; T. Hudson, secretary; meeting, Sept. 23; a company is proposed for a line from Cockermouth, by Keswick, Ambleside, to Windermere, called the Furness and Windermere; deviation of line at Kendal proposed at an increased cost of 25,000*l.*

53. *Lowestoft Railway and Harbour.*

6,000 shares of 20*l.* each; capital 120,000*l.*

From Lowestoft, through Thorpe, Loddon, and Reedham, terminating in junction with the Yarmouth and Norwich line. Length of line, 11 miles; number of shares subscribed for, 5117; and capital, 103,920*l*; authorised loan, 40,000*l.*; estimated expense, 120,000*l.*; recommended by the Board of Trade, and by committee of group K; single line; working expenses, 2,760*l.* per annum; royal assent, June 30; G. P. Bidder, engineer; secretary, Richard Till, offices, Guildhall-buildings, London, and at Yarmouth and Norwich.

54. *Manchester and Leeds Branches Junction.*
Capital 360,000*l.*

Extension of the Oldham and Heywood Branches, also of Burnley Branch to join the Manchester, Bury, and Rossendale line; capital subscribed, 340,000*l.*; authorised loan, 120,000*l.*; length of line, 13 miles, 7 feet, 8 chains; estimated expense, 360,000*l.*; recommended by the Board of Trade, and committee of group B; royal assent, June 30. J. Stephenson, engineer; office, Palatine-buildings, Hunt's Bank, Manchester; F. Laurentz Campbell, secretary.

55. *Bedford and London and Birmingham.*
2,500 shares; capital 125,000*l.*

In junction with the London and Birmingham at Bletchley, running through a rich agricultural district by Maiston, terminating at Bedford. Length of line, 15 miles, 7 furlongs, 4 chains; number of shares subscribed for, 2,187, and capital 109,350*l.* Authorized loan, 41,650*l.* Estimated expense, 125,000. Recommended by the Board of Trade, and by committee of group T; working expenses, 40 per cent. Royal assent, June 30; R. Stephenson, engineer; scrip exchanged for certificates 25th July; B. F. Scott, Secretary, 11, Old Jewry, chambers, London.

56. *Wakefield, Pontefract, and Goole.*
7,300 shares of 50*l.* each; capital 365,000*l.*

Connect the port of Goole and Pontefract with the districts of Lancashire and Yorkshire, and by a junction with the York line near Snaith, with all parts of the Kingdom. Length of lioe 28 miles; capital subscribed, 360,000*l.*; authorized loan, 121,666*l.*; recommended by the Board of Trade and committee of group W; working expenses 40 per cent.; royal assent, July 31; J. Harris, engineer. Methley extension, 25 shares, 1 new for 1 old, and new stock for proposed Great Grimsby, and Sheffield, and Wakefield, and Pontefract, and Goole, is to be raised ⅔ by Grimsby, ⅓ by Wakefield and Goole; the latter in shares of 20*l.* each, one new for every old.

57. *Great Grimsby, and Sheffield Junction.*
12,000 shares of 50*l.* each; capital 600,000*l.*—Amalgamation.

To open a communication from Liverpool on the west of Grimsby, on the Eastern coast, and furnish the manufacturing and agricultural districts with a communication with each other, and access to a safe port on the Eastern Coast. Length of line, 59 miles, 4 furlongs, 5 chains; the whole subscribed for; authorized loan, 20,008*l.*; estimated expense 590,750*l.*; working expense, 30 per cent.; royal assent; June 30; J. Fowler, engineer; amalgamated with the Sheffield, Manchester, and Sheffield, and Lincolnshire companies, as also the Great Grimsby dock and railway, and propose to include the intended East Lincolnshire Company; Secretary, J. H. Humfrey, Sheffield.

58. *Midland (Extension.)*

From Nottingham to Lincoln, 33 miles, 5 furlongs, 3 chains, for which the authorised loan is 136,000*l.*, and an increase of the capital stock of 408,000*l.*, estimated expense 408,000*l.*, extension from Lyston to Peterborough, 15 miles, 7 furlongs, 4 chains, for which the authorised loan is 41,650*l.*, or 250,000*l.* The increase of the capital stock 750,000*l.*; estimated expense 750,000*l.*; capital subscribed, 109,350*l.* more for the Nottingham and Lincoln; royal assent, June 30; working expenses, 14,000*l.* per annum for Lyston and Peterborough; engineer, Messrs. Gand, R. Stephenson, and F. Swanwick. Bought the Ashby-de-la-Zouch canal for 110,000l.; proposes to make a line by Hinkley and Moira, to Burton on Trent, also a canal railway, of Midland gauge, to Grisley Common, also Leicester, Swannington railway, for 140,000*l.* at 8 per cent, 10,000*l.*; for working stock; 7,000*l.* debt redemption in 3 years.

59. *London and South Western, (Metropolitan Extension, No.* 1.)

From Nine Elms to Waterloo and Hungerford bridges; length of line, 2 miles; capital subscribed, 739,180*l.*; authorised loan, 233,000*l.*; estimated expense, 800,000*l.*; capital stock, 800,000*l.*; recommended by the Board of Trade, and committee of group LL.; royal assent, July 31; J. Locke, Engineer.

60. *Bristol and Exeter (Branch.)*
5,000 shares of 100*l.* each; capital 500,000*l.*

Length of line, 29 miles; number of shares subscribed for, 2,850*l.*; and capital 205,000*l.*; authorised loan, 166,600*l.*; estimated expense, 375,000*l.*; forming a junction between Bristol and Exeter, and the Great Western line in the city of Bristol, with a branch to Yeovil; recommended by the Board of Trade and committee of group G.; working expenses, 35 per cent; royal assent; July 31; I. K. Brunel, engineer; leased to Great Western Railway, and proposed sale as follows: on capital, 1,080,000*l.*, and 450,000*l.*, to call up at 10*l.* each, at intervals of six months, until January 1849; for 100*l.* shares and until January 1, 1852, for the ½ shares. After January 1st. 1838, to have 6 per cent on a capital of 2,000,000*l.*, contingent on any new line or narrow gauge between Exeter and London; if much is passed only to have 5½ per cent.

61. *Leeds and Bradford, (Extension) Shipley to Colne.*
Capital 500,000*l.*

From the Leeds and Bradford Railway at Shipley in Bradford, to Colne, in Lancashire; length of line, 30 miles, 4 furlongs, 5 chains; capital subscribed, 382,500*l.*; power to borrow 166,666*l.*; estimated expense, 500,000*l.*; recommended by the Board of Trrde, and committee of group D.; working expenses, 40 per cent.; royal assent; June 40; H. Fulton, engineer; Office, Hunslet lane, Leeds; Secretary, W. E. Greenland.

62. *Birmingham and Gloucester, (Gloucester Extension, Stoke Branch, and Midland Junction.)*

Commences at the junction near Birmingham, and terminates in junction with the Midland Railway at Aston, with branches to Stoke Prior, Worcester, and Droitwich; length of line, 1 mile, 6 furlongs, 1 chain; no shares subscribed or power to borrow obtained; recommended by the Board of Trade; working expenses, 40 per cent.; August4; J. Baylis, engineer.

63. *Aberdare.*
1,000 shares; capital 50,000*l.*

Length of line, 8 miles, 5 furlongs, 2 chains, from Aberdeen to Taffs Vale Line, near Ynys; authorised loan, 16,600*l*; single line; royal assent; July 31; William Barber, engineer.

64. *Ashton, Staley Bridge, and Liverpool Junction. (Ardwick and Guide Bridge Branches.)*

Length 1¾ miles, Manchester and Birmingham Line, and Ardwick to Ashton, Staley Bridge, and Liverpool Line, and Newton; estimated expenses, 90,000*l.*; capital, 90,000*l.*; authorised loan, 30,000*l.*; working expenses, 33 per cent.; date of act, July 21; Hankshaw, engineer.

65. *Berks and Hants.*
8,000 shares; capital 400,000*l.*

Length of line 39 miles; Termini, Newbury, Hungerford, South Western, near Basingstoke, and Great Western near Reading; authorised loan, 133,330*l.*; expense 40 per cent.; June 30, 1845; I. K. Brunel, engineer.

66. *Blackburn and Preston Deviation.*
Capital 52,468*l*; loan 10,000*l.*

Length of line, 3 miles, 4 furlongs, 3 chains; Termini, Blackburn and Preston Line in Blackburn, and Blackburn, Burnley and Colne line, in Blackburn; capital, 30,000*l.*; estimated expenses, 66,989; royal assent; July 21; Collister, engineer.

67. *Brighton, Lewis, and Hastings (Branch Extension).*

Keymer branch, 9 miles, 1 furlong, 2 chains; 2,800 shares; authorised loan, 46,666*l.*; Hastings, Rye, and Ashford extension, 29 miles, 7 chains; 10,000 shares; authorised loan, 166,000*l.*; increase of capital, 500,000*l.*; and for Keymer branch, 140,000*l.*; and extension of Brighton and Chichester (Portsmouth Extension), 22 miles; 6,400 shares; increase of capital, 320,000*l.*; single line; authorised loan, 106,666*l.*; date of act August 8; J. J. Rastrick, engineer. The Portsmouth Extension is from the Brighton and Chichester line, to Fareham, on the London and South Western, and the Hastings, from Hastings to Ashford on South Eastern. The Brighton, Lewes, and Hastings line is extended from Southover and Lewes, to the Brighton line at Keymer. Sold to the Brighton line for 7*l.* per share premium, by act had power to sell at 482,000*l.*, the estimated act, and 10*l.* per share additional. Boyman, Secretary, Office, 11, King William-street, City.

68. *Chester and Birkenhead (Extension.)*

Length, 7 furlongs; capital subscribed, 225,000*l.*; authorised loan, 100,000*l.*; capital stock, 300,000*l.*; estimated expenses, 250,000*l.*; from Grange-lane to Grange-end; date of act, July 21; G. T. Payne, engineer.

69. *Chester and Holyhead.*

Length, 4 miles, 4 furlongs, 6 chains; estimated expense, 500,000*l.*; date of act, June 20th; Robert Stephenson, engineer; Secretary, George King; Office, 62, Moorgate-street, London.

70. *Cockermouth and Workington.*
4,000 shares; capital 80,000*l.*

Length of line, 8 miles, 6 furlongs, 7 chains; estimated expense 30,000*l.*; authorised loan, 26,666*l.*; number of shares subscribed, 3,113; and capital, 62,160*l.*; working expenses, 40 per cent.; single line; date of act, July 21; John Dixon, engineer. From Cockermouth to Whitehaven line at Workington Harbour; G. H. Barnes, Secretary, Cockermouth.

71. *Direct London and Portsmouth.*
Capital 1,500,000*l.*: loans 500,000*l.*

Estimated expenses, 1,450,000*l.*; returned as passed in return of House of Commons, printed August 8, 1845.

72. *Dunstable, London, and Birmingham.*
2,500 shares; capital 50,000*l.*

Length of line, 7 miles; authorised loan, 16,600*l.*; number of shares subscribed for, 119; capital, 2,392*l.*; estimated expense, 50,000*l.*; working expenses, 1,720*l.* per annum; single line; date of act, June 30; Rober Stephenson, Engineer; Secretary, Thomas Long; registered, August 27; Office, Euston-square, London.

73. *Eastern Union (Ipswich and Bury St. Edmunds.)*

16,000 shares; capital, 400,000*l.*

Length of line, 26 miles, 6 furlongs, 3 chains. Number of shares subscribed for, 1,2680, and capital, 317,000*l.*; authorized loan, 133,333*l.*; estimated cost, 400,000*l.*; from Eastern Union line at Ipswich to Bury St. Edmunds; working expenses, 40 per cent.; date of act, July 21, 1845; P. Bruff, engineer; office, Brook-street, Ipswich; secretary, James F. Saunders.

74. *Edinburgh and Glasgow.*

Length of line, 6 miles, 2 chains; capital subscribed, 216,000*l.*; authorised loan, 23,000*l.*; capital stock, 100,000*l.*; estimate of expense, 52,000*l.*; working expense, 30 per cent.; date of act, July 31; J. Miller, engineer; branch to Stirling.

75. *Edinburgh and Hawick.*

32,000 shares; capital, 400,000*l.*—Amalgamation.

Length of line, 45 miles, 2 furlongs, 8 chains.; authorised loan, 133,333*l.*; single line; working expenses, 40 per cent.; date of act, Aug. 6; J. Miller, engineer.

76. *Erewash Valley.*

3,800 shares; capital, 190,000*l.*

Length of line, 13 miles, 6 furlongs; shares subscribed, 2,920; capital, 146,000*l.*; authorized loan, 63,000*l.*; estimate of expenses, 187,000*l.*; date of act, July 21; working expenses, 30 per cent.; engineer, G. Cope; from the Midland line, at Lawley, Derbyshire, to Mansfield and Pinxton line at Selston, Nottinghamshire; secured to the Midland at 6 per cent.

77. *Epping (Eastern Counties Junction.)*

8,000 shares; capital, 2000,000*l.*—Amalgamation.

Length of line, 1 mile, 6 furlongs. Authorised loan, 66,600*l.* Number of shares subscribed for, 750, and capital 18,750*l.* Estimate of expense, 200,000*l.* From London to Blackwall and Eastern Counties' line. Date of act, Aug. 4. Robert Stevenson, engineer in Blackwall.

78. *Glasgow Junction.*

Capital, 150,000*l.*

Length of line, 2 miles, 2 furlongs; capital subscribed, 224,000*l.*; authorized loan, 50,000*l.*; estimated expense, 150,000*l.*; date of act, 3d and 21st July; engineer, J. Miller.

79. *Glasgow, Paisley, Kilmarnock, and Ayr (Cumnock Branch in Extension.)*

Capital, 204,000*l.*

Length of line, 18 miles, 3 furlongs, 6 chains; estimated expense, 350,000*l.*; authorised loan, 68,000*l.*; working expenses, 30 per cent., and estimated expense, 440,000*l.*; capital stock in trade, 312,500*l.*; authorised loan, 104,166*l.*; engineer, J. Miller; printed in parliamentary return as having passed the House of Commons.

80. *Great North of England (Clarence and Hartlepool Junction.)*

Capital, 21,000*l.*

Authorised to borrow 7,000*l.* Length of line, ¾ of a mile; date of act, July 21; engineer, Joseph Stevenson; estimated expense, 2,772*l.*

81. *Great North of England and Richmond.*

150,000 shares;

Length of line, 9 miles, 8 furlongs, 3 chains; capital subscribed, 249,940*l.*; estimated expense, 112,383*l.*; authorised loan, 50,000*l.*; working expenses, 40 per cent.; date of act, July 21, 1845; engineer, Joseph Stevenson.

82. *Guilford, Chichester, and Portsmouth.*

Capital 500*l.* Amalgamation.

Guilford Junction, purchased by South Western; capital stock in shares, 500,000*l.*; authorised loan, 166.666; length of new line, 15 miles; Fareham branch; estimated working expense, 9,300*l.* per annum; date of act, July 21, 1845; engineer. J. Locke; capital, 885,000*l.*; — Rand, secretary.

83. *Huddersfield and Manchester Railway and Canal.*

21,600 shares; capital, 630,000*l.*

Length of line, 22 miles, 7 furlongs, 1 chain. Number of shares subscribed for, 700, and capital, 506.130*l.*; authorised loans, 210,000*l.*; estimated expense, 630,000*l.* From Sheffield and Manchester line at Staley-Bridge to Manchester. Leeds, at Kirkheaton; estimated working expense, 40 per cent.; date of act, July 21; engineer, J. Locke; secretary, Edward Ledgard, Guildhall, Huddersfield, Aug. 18.

84. *Huddersfield and Sheffield Junction.*

[illegible] shares; capital, [illegible]

Length of line, 15 miles, 4 furlongs, 6 chains. Number of shares subscribed for, 9,220, and capital, 461,000*l.*; authorised loan, 177,333*l.*; estimate of expenses, 531,258; from Huddersfield to the Sheffield and Manchester line at Penistone; date of act, 30th June; engineer, A. S. Jee; amalgamated with Manchester and Leeds, 10,640*l.*; stock of latter company interested in proposed Huddersfield, Halifax, and Bradford, West Riding and West Yorkshire Companies, and propose to extend from Hozins to Barnsley.

85. *Hull and Selby (Bridlington Branch.)*

8,640 shares; capital, 2,161,000*l.*

Length of line, 31 miles. Number of shares subscribed, 6,612, and capital, 165,300*l.*; authorised loan, 72,000*l.*; estimated expense, 216,000*l.*; From Hull and Selby line to Bridlington; date of act, 30th June; engineer, R. Stephenson.

86. *Liverpool and Bury (Bolton, Wigan and Liverpool, and Bury Extension.)*

18,240 shares; capital, 912,000*l.*—Amalgamation.

Length of line, 34 miles, 1 furlong, 20 chains.; number of shares subscribed for 13,978, and capital, 698,900*l.*; authorized loan, 304,030*l.*; estimated expense, 962,000*l.*; estimate of working expense, 40 per cent.; date of act, July 31, 1845; engineers, James Thompson and Sir John Macneill; 5th call, October 18; amalgamated with the Manchester and Leeds, Monday, October 8.

87. *London and Croydon Enlargement.*

Capital, 180,000*l.*

Length of line, 12 miles, 4 furlongs; capital subscribd, 140,000*l.*; authorised loan, 60,000*l.*; date of act, August 8; engineer, C. H. Gregory.

88. *London and Brighton (Horsham.)*

Capital, 100,000*l.*

Length of line, 8 miles, 3 furlongs; capital subscribed, 75,000*l.*; authorised loan, 33,333*l.*; estimated expense, 100,000*l.*: from Three Bridges Station, on the Brighton line, to Horsham; working expenses, 40 per cent.; date of act, July 21, 1845; J. H. Rastrick, engineer.

89. *Manchester and Birmington (Ashton Branch.)*

Length of line, 5½ miles; estimated expense, 93,000*l.*: from Heaton Norris to Sheffield and Manchester line near Guide Bridge; working expenses, 30 per cent.; date of act, July 21; engineer, W. Baker.

90. *Manchester South Junction and Altrincham.*

Capital, 400,000*l.*

Length of line, 9 miles, 3 furlongs; subscribed capital, 400,000*l.*; authorised loan, 133,333*l.*; estimated expense, 400,000*l.*; from Manchester and Birmingham, and Manchester and Liverpool lines at Altringham; working expenses, 40 per cent.; date of act, July 21; engineer, W. Baker; secretary, John Latham; office, Manchester and Birmingham Station, Manchester.

91. *Middlesborough and Redcar.*

720 shares; capital 36,000*l.*; deposit 2*l.* 1*s.*

Length of line, 7 miles, 5 chains; number of shares taken, 569; capital subscribed, 28,450*l.*; authorised loan, 12,000*l.*; estimated expenditure, 36,000*l.*; working expenses, 40 per cent.; date of act, July 21; single line; engineer, John Harris; amalgamated, and guaranteed 5 per cent by the Great North of England and Stockton and Darlington companies, and division of half the profits; 10*l.* paid November 4; Mr. Magnay, secretary; office, North Gate, Darlington.

92. *Monmouth and Hereford.*

11,000 shares; capital 550,000*l.*

Length of line, 36 miles, 2 furlongs, 8 chains; shares subscribed for, 8,250; capital, 412,500*l.*; authorised loan, 183,333*l.*; estimated expense, 550,000*l.*; working expenses, 40 per cent.; date of act, July 31; engineers, George and Robert Stephenson; from the Cheltenham and Great Western Union line to Monmouth and Hereford; sold to Great Western.

93. *Newcastle and Darlington (Brandling Junction).*

Capital 6500,00*l.*

Length of line, 5 miles, 7 furlongs; capital subscribed, 13,000*l.*; authorised loan, 216,000*l.*; estimated expense, 90,000*l.*; working expenses, 4,087*l.* per annum; date of act, July 21; engineer, T. E. Harrison.

94. *Newcastle-upon-Tyne and North Shields (Tynemouth Extension).*

1,000 shares; capital 50,000*l.*

Length of line, 1 mile; authorised loan, 16,666*l.*; estimated expense, 49,091*l.*; working expenses, 40 per cent.; date of act, June 30; engineer, Robert Nicholson.

95. *Newport and Pontypool.*

1,191 shares; capital 119,100*l.*

Length of line, 14 miles, 2 chains; number of shares subscribed for, 900; capital, 90,000*l.*; authorised loan, 78,163*l.*; estimated expense, 129,000*l.*; working expenses, 40 per cent.; date of act, 31 July; engineer, T. Marsh.

96. *North British.*

Capital 20,000*l.*

Length of line, 1 mile, 7 furlongs; estimated expense, 47,000*l.*; authorised loan, 53,333*l.*; date of act, 21 July; engineer, J. Miller; secretary, J. F. Davison, 24, St. Andrew-square, Edinburgh.

97. *North Union and Ribble Navigation (Branch).*

Length of line, 64 chains, 7 furlongs; from North Union line to Victoria Quay, Preston; estimated expense, 16,000*l.*; authorised loan, 6,666*l.* working expenses, 25 per cent.; date of act, 21 July; engineer, William Coulthard.

98. *North Woolwich.*

1,200 shares; capital 30,000*l.*

Length of line, 2 miles, 6 furlongs, 6 chains; number of shares taken, 900; capital, 22,000*l.*; authorised loan, 10,000*l.*; estimated expense, 30,000*l.*; Eastern Counties; single line; working expenses, 40 per cent. date of act, July 21; engineer, G. P. Bidder; from the Eastern Counties line, near the mouth of the Lea, to North Woolwich.

99. *Norwich and Brandon (Deviation), and Diss and Dereham (Branches).*

Capital 220,000*l.*

Length of line, 17 miles; capital subscribed, 176,210*l.*; authorised loan, 73,300*l.*; estimated expense, 100,000*l.*; working expenses 27 per cent.; date of act, 31 July; engineer, G. P. Bidder.

100. *North Wales Mineral.*

15,000 shares; capital 150,000*l.*

Length of line, 12 miles, 1 furlong, 9 chains; number of shares subscribed for, 11,415; capital 114,150*l.*; authorised loan, 50,000*l.*; estimated expense, 45,586*l.*; from North Wales Mineral line to Ruabon; working expenses, 40 per cent.; date of act, July 21; engineer, P. Robertson; secretary, John Marriner; meet at the London Tavern.

101. *Sheffield and Rotherham.*

Capital 45,000*l.*

Length of line, 3 furlongs, 2 chains; estimated expense, 45,000*l.*; from Sheffield and Rotherham line to Sheffield and Manchester line, in Brightside, Burlow, Sheffield; amalgamation with the Midland; date of act, July 21; engineer, Mr. Swanwick.

102. *Wear Valley.*

1,650 shares; capital 82,000*l.*

Length of line, 11 miles, 6 furlongs; number of shares subscribed for, 1,300: capital, 65,000*l.*; authorised loan, 27,330*l.*; estimated expense, 82,000*l.*; from Crock branch of the Bishop Auckland line to Watchlass Hill, Frosterley; date of act, July 31; engineer, John Dixon; Thomas M'Nay, secretary, Darlington.

103. *Whitby and Pickering.*

Capital 135,000*l.*

Sale to York and North Midland; estimated expense, 135,400*l.*; authorised loan, 45,000*l.*; date of act, 30 June; engineer, J. Stephenson.

104. *West London.*

Capital 60,000*l.*

Length of line, 1 mile, 5 furlongs, 1 chain; from West London, at Kensington, to a point near Battersea Bridge; estimated expense, 60,000*l.*, authorised loan, 20,000*l.*; working expenses, 40 per cent.; date of act, July 31; engineer, R. Stephenson.

105. *Yarmouth and Norwich.*

Capital 40,000*l.*

Length of line, 2 furlongs, 5 chains; estimated expense, 40,000*l.*; date of act, June 30; engineer, J. P. Bidder; see also Lowestoft railway; office, Guildhall-buildings, London; secretary, Richard Till.

106. *Hayle and Redruth.*

From Redruth, through Cain Brea, Camborne, to Hayle, in Cornwall; negotiating for sale to West Cornwall; secretary, Mr. Fleming, Old Broad-street, London.

The Magnetic Telegraph.—The establishment of magnetic telegraphs, radiating from New York to the east, west, and south, to the extent of three or four hundred miles, so as to connect all the large cities of the Atlantic border with this metropolis, is now in a rapid state of progress. The line between this and Buffalo is under weigh, and so also is the one to Boston, so likewise that between this city and Washington, including all the intermediate points. There is also a line commenced between this city and Coney Island. All these lines are conducted by associations of individuals who derive their powers from the inventor, Professor Morse, now in Europe. It is supposed that the whole of them will be finished in the course of three or four months; and that the principal line between this city and Washington will be completed in time to transmit the next message of the President to this city, and to enable the publishers to issue it simultaneously with the Washington papers. When completed these united lines of telegraphic communication will embrace a territory of nearly 500 miles from south to north, and from east to west—including within its ramifications the metropolis, Washington, Buffalo, Boston, with all the intermediate cities, as parts of the grand scheme of communication. Such a system of telegraphic communication of all descriptions of news will make the great Atlantic cities suburbs of this metropolis, and all animated by the same spirit and the same impulses, numbering, probably, a population of nearly two millions of the most active, talented, intellectual, impulsive, and most energetic business men on the face of the earth. It will not be forgotten that this vast and comprehensive scheme of telegraphic communication will be completed in the course of a few months, and be in the hands of individuals for their own advantage and purposes, without any responsibility to government or society in any particular whatever. One of the lines of telegraph, and the shortest and most unproductive, that between this city and Coney Island, has already made propositions to the newspapers, offering to give them intelligence of ship news and other marine matters at the rate of 50 dollars per week—a sum nearly double that which is now paid under the old method. This is a sample of what may be expected from the other companies and associations, provided they should be allowed to establish their vast and comprehensive schemes without being liable and responsible to any of the legislative powers of the country. In fact, we believe that the magnetic telegraph is going to produce a greater change in some of the social institutions of the country than any one now imagines.—'New York Herald.'

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

1st December, 1845.—J. B. Papworth, V.P. in the Chair.

A paper was read by John Whichcord, jun., Associate, on

Kentish Rag Stone as a Building Material.

This stone, now so much used in the metropolis, is principally quarried in a district extending about 30 miles east and west, through the centre of Kent, and having a breadth of from 4 to 10 miles. This district, which comprises the towns of Sevenoaks, Maidstone, Lenham, &c. has its surface within the limits of the green or Shanklin sand. The character of the sand varies considerably in the district alluded to, and the qualities of the building materials which it yields are therefore very different.

Geological Character.

The Kentish Rag Stone is usually found in beds of from 6 inches to 2 feet in thickness, and these different layers are invariably separated by a species of sand, known by the name of Hassock, which, in some cases, is sufficiently indurated to present a tolerably good working stone, used frequently in the neighbourhood as an inside lining to external Rag Stone walls. Mr. Whichcord principally confined his remarks to the quarry at Boughton, in the neighbourhood of Maidstone, from which the best qualities of Rag are now obtained, and a drawing was exhibited to the meeting, which represented a section of the strata in this part of the district. The quarry at Boughton has been worked for some centuries, and from it was very probably procured the stone employed in the metropolis during the period when the pointed style of architecture prevailed. Stones of a spherical shape, such as were used in the 14th and 16th centuries for artillery, are still found among the accumulated rubbish.

At Boughton, as in most of the Rag Stone districts, the surface layer of vegetable mould is succeeded by a bed of loam, which is sometimes 15 feet in depth, and varies in its character as it descends, changing from a stiff brick earth to a kind of gravelly loam, called in the district *Red Pins*. It is succeeded by three veins of ferruginous sand of a red colour, alternating with the same number of layers of fine Hassock, which in this case retains its sandy character, and forms, with the Rag Stone lime, a very excellent mortar.

Beneath the third bed of Hassock is found the first of about 20 layers of limestone, which bears the name of *Land Rag*, and is found much broken. It continually occurs, that this bed thins off into detached modules, and sometimes ceases altogether. Its thickness is therefore very variable, but blocks of from 5 to 6 feet in length, and 8 to 10 inches deep, can occasionally be procured from it. The stone is here tolerably free to work.

As previously stated, this bed of stone is (as are all others of the strata) followed by one of Hassock. The second bed of stone is called the *Header-Layer*, used for headers. The next is the *Green Rag*, which frequently divides and re-unites, the intervening space being filled with the Hassock sand: it is green in colour, and free to work, though not very sound. The layer of Hassock, which succeeds the Green Rag, is workable, and is much used in the neighbourhood for the purpose before mentioned; it requires very little labour in dressing, and in the quality of resistance to moisture is superior to brick. The next bed of stone is called the *Yellow Rag*, and is used principally for pitching; it is succeeded by the *Pelsea*, from which the largest blocks can be procured, some of 12 inches in thickness; it is very hard and strong.

The next two layers of Rag are called the *Coleman* and the *Little Coleman*, and are of a hard flinty nature; they are sometimes used as headers. We have then the *Great Rag*, which is a bed of considerable depth, sometimes as much as 3 feet; but as it very often cleaves into two thicknesses, and is full of crosses, no stones of a large size can be procured from it; it is much used for lime, of which it affords the best quality. The bed of Hassock immediately under the Great Rag is of a very superior quality, being of a fine, close, and free working grain, resembling the Reigate Stone, and stands exposure to the weather exceedingly well. It is followed by the *Newington Cleaves*, which, like the Great Rag, often splits into two layers; it is very hard and flinty. Two beds of Hassock, separated by a thin flinty layer of Rag Stone, intervene between the cleaves and the *Whiteland Bridge*, which is equal in quality to any in the quarry; blocks of 12 feet in length, and of almost any breadth, can be procured from it; its workable thickness is about 14 inches.

The next in order is the *Mainbridge*, similar to the preceding bed, though no stones of such large scantling can be obtained from it. It is separated by a layer of inferior Hassock from a bed called *Garl*, used generally for headstones.. The *Horsebridge* succeeds it: this is a good stone; blocks can be procured from the bed 15 feet long, and 16 inches thick. The next layer, called *Headstone Layers*, is about 7 inches thick. This is followed by two or three header layers, inferior in quality, and alternating with their respective beds of Hassock, below which are what are termed the *upper* and *under bottom layers*. These yield stones of good quality and colour, and of considerable size. Next comes the White Rag, a soft stone, resembling chalk, and crumbling on exposure to the atmosphere; it reposes on a bed of hassocky clay, below which the quarrymen have not penetrated, it being very doubtful whether any lime-stone would be found beneath it; indeed, in some quarries, it has not been thought worth while to work even as low as this. Mr. Whichcord then mentions that the most favourable manner of working these quarries is to expose the whole section of the cliff, and carry on the work in such a way as to lay open the upper surfaces of each of the best layers of stone in some convenient part of the quarry. By this means the largest scantling can be procured at once, and the frequent difficulty attending the working of quarries in a different manner (that of obtaining large stones when wanted in haste).

Practical Properties.

With respect to the mechanical properties of the stone, it stands next to granite in the list of British stones in respect of resistance to pressure—but the vents to which even the best quality of this stone are liable, render is unsafe when applied in such a manner, that the strain acts transversely to the length of the block. Mr. Whichcord then described the various modes of working and dressing the Kentish Rag Stone, mentioning that, as Ashler, it is usually worked with a pick, instead of being tooled, as the "Hassocky" spots which continually occur in it give it, when smooth, the appearance of bad Portland.

With reference to the mortars made with lime burnt from this stone, it was mentioned, that it attains, after a time, a degree of hardness *equal* to, and, in some cases, even *greater* than the Rag Stone itself. The durability of Rag Stone wall-work can therefore best be depended on when used with this mortar.

Mr. Whichcord referred to the mode of burning lime in the neighbourhood of the quarries, and the quantities used in making concrete, viz.—six of broken stone, two of sand, and one of lime. He also gave a list of the prices, both at the quarry and at London, of the various qualities of stone, and of the prices of labour at Boughton.

Chemical Analysis.

The following analysis of the Kentish Rag Stone was made for Mr. Whichcord's paper by Mr. Phillips, of the Museum of Economic Geology:—

Carbonate of lime, with a little magnesia,	92·6
Earthy matter,	6·5
Oxide of iron,	0·5
Carbonaceous matters,	0·4
	100·0

Hassocks.

Carbonate of lime,	26·2
Earthy matters,	72·2
Oxide of iron,	1·8
	100·0

ROYAL EXCHANGE.

December 15th, 1845.—Mr. KENDALL, V.P. in the chair.

Mr. Tite read a paper.

"*On the Original Foundation and Erection of the Royal Exchange, by Sir Thomas Gresham, with some Notices of the late Building destroyed by Fire, and an Account of the Roman Antiquities discovered in excavating for the Present Edifice.*"

The first branch of his subject Mr. Tite illustrated by numerous extracts from the records of which the corporation of London possesses a rich collection, commencing with the original charter granted to the city by William the Conquerer, a document which he incidentally describes as being comprised in a few lines in the Anglo-Saxon language. Coming, then, to the authorities more immediately connected with the subject, Mr. Tite detailed the transactions relating to the building of the Royal Exchange, through the munificence of the princely merchant, by whom the whole expense of the structure was undertaken, on condition that the site should be provided by the city, from his first proposal to that effect in 1564. The purchase of the site cost the citizens 3,532*l.* 17*s.* 2*d.*, including freeholds, leaseholds, and tenants' interests; and it is to be noted that the former class of property realized about twenty-three years' purchase—a value not very different from the average of later times. The building was completed and opened for use in 1567. During the progress of the work, a question appears to have arisen between Sir Thomas and the city respecting the *property* in the building, which terminated in his assuring, after his own life, half the profit of the shops and other tenements to the Corporation, and half to the Mercers' Company; and it is from this division that the affairs of the Exchange have always been in the hands of the mixed body called the Gresham Committee. The appearance of the original building is preserved to us in Hollar's engraving, which shows it to have been in a much better style of architecture than the Bourse of Antwerp, of which it has been pretended it was a copy. That of Amsterdam bears a much greater resemblance to it, but in this case the London building is the original, and not the copy; that of Amsterdam dated only from 1612. Shortly after the death of Sir thomas Gresham, some part of the building failed, upon which occasion the members of the Corporation endeavoured to cast the repairs upon the widow of their benefactor. From a report made by the Gresham Committee, after the destruction of the building in the great fire, it appears that the arcades of the court were vaulted with stone, and that it had been necessary to stay the supporting pillars by transverse iron ties. This report is dated on the 17th September, 1666, so that the committe had lost no time in taking measures to repair the calamity they had suffered. Estimates for the new building were speedily provided by Messrs. Mills and Jerman, who appear to have proceeded in the plan of making out quantities, and giving them to the tradesmen to be priced. After some coquetting on the part of the latter, who professed to deprecate any interference with the office of city surveyor, held by Mills, Jerman was at last appointed the architect, and the first stone of the new edifice was laid by King Charles II., on the 23rd of October, 1667. In erecting the new edifice, the site was considerably enlarged, and it was the wish of the citizens to disengage the building from the houses, late Sweeting's Alley, which pressed upon it to the eastward, encouraged by an offer of the proprietor, Sweeting, to dispose of his property on the most liberal terms, and which ended, as such offers usually do, in demands too exorbitant to be complied with. The tower of Jerman's building, which, from motives of economy, was constructed of timber insead of stone, yielded to the effects of time in 1818, and was replaced by a stone cupola, designed by Mr. George Smith, architect of the Mercer's Company. With reference to the building lately completed under his superintendence, Mr. Tite confined himself to the antiquities. Four glass cases, containing a numerous selection, were laid on the table, consisting of pottery, coins, writing tablets and styles, a great variety of objects in metal, and a quantity of shoes and sandals in excellent preservation. The whole of these curious objects were found in one spot, at a depth below the general level of the solid ground, and bedded in black mud—evidence that it had been a pond, and the receptacle of rubbish for the neighbourhood during the period of Roman London. Mr. Tite concluded with a powerful appeal to the members of the profession in general, on the subject of the preservation of Antiquities, and of supporting the measures recommended by Mr. Hawkins, in his letter read at a former meeting.

SOCIETY FOR THE ENCOURAGEMENT OF ARTS.

The First Meeting of the Society for the encouragement of Arts, Manufactures, and Commerce, took place on the 17th, in the great room of the Society, in the Adelphi, which was completely filled.

B. BOND CABBELL, Esq., F.R.S., one of the Vice Presidents, took the Chair, and an address from the Council was then read by the Secretary. The Council congratulated the society on the auspicious commencement of their *ninety-second session.* During the recess the society had undergone a complete reorganization, and the new system of management proposed by the Council had been almost unanimously confirmed by two general meetings, so that the society being thus rewarded, its youth would, it was anticipated, display all the vigour and energy of a new institution, combined with the stability and influence of an old one.

It was the intention of the council to add largely this year to the value and number of the premiums. In the fine arts, the mechanical arts, the manufactures, agriculture, and commerce of the country—rapid improvements were in progress, which it had been the peculiar province of this society for nearly a century to encourage and direct, and in which nearly 100,000*l.* had already been expended by it with great public advantage. In the present session many valuable subjects were about to be offered for competition by premiums, and so large a number of important papers were coming forward for notice, that the Council believed the auspicies under which this session commenced were unusually bright, and they therefore had to congratulate the members upon the improved prospects of the society.

Broad and Narrow Gauge

The first communication read to the society was a paper on certain improvements, in constructing the Locomotive Engines, and permanent Way of Railways, with reference to the question of wide and narrow gauge, by J. G. Bodmer, Esq., formerly of Manchester, now of London. In this paper the author examines the question of the relative merits of wide and narrow gauge; he ascertains that the question is not one either of relative safety or danger, but that it resolves itself ultimately into this question, which gauge will admit of the most perfect means for obtaining high velocities with greater regularity and economy. At present he admits the broad gauge has the advantage in more powerful and speedy engines. But he then proceeded to show that by placing the *cylinders outside*, and by *increasing* the firebox and the flue surface in the manner he proposes, and by adopting the principle of compensation as in his double piston locomotives, high velocities may be obtained with security, safety and advantage. In short, that as powerful an engine in every way may be placed on the narrow gauge as on the wide one, and one equally well adapted to high velocities. He then went on to show how the chief limit in increase of power, and the corresponding increase of weight in locomotive engines, consists not so much in the construction of the engines, as in obtaining a permanent way suitable for the support of such enormous loads. By these loads travelling at high velocities concussions are produced which derange the permanent way, and are at present the chief sources of danger and cost, and the chief limit to the speed. He approves of the triangular sleeper, originally invented by Reynolds, and he proposes to use a modification of that on a larger scale, as a longitudinal bearing. He also proposes that the breadth of the rail should be so increased as to diminish the continual attrition so destructive to wheels, and procure greater durability. In the conclusion of the paper he suggests that an experimental railway ought to be constructed either at the expense of the government, or of the joint railways, for ascertaining the best means for giving the increased velocity which the public are beginning to demand in the best manner. The paper gave rise to a long and interesting discussion, which elicited the opinions of engineers and scientific men present on the merits of Mr. Bodmer's plan. The principle on which his engines are constructed were approved by all who spoke on the subject, and the thanks of the meeting were unanimously accorded to the author. The next paper read was a sequel to the former by the same author, on improved crank axles and axle boxes, by which greater security and economy are obtained in railway trains running at high velocities. There were other papers on the list of the evening, one of them containing a valuable discovery by Mr. Nott, on the nature of the Photographic rays, and a method by which a great improvement is effected in Daguerreotype pictures. But the length and interest of the discussion rendered it necessary to postpone that and the other communications to a future meeting. The meeting was crowded and deeply interesting, and augurs well for the prosperity of the society under the new regime.

ROYAL SCOTTISH SOCIETY OF ARTS.

Monday, Nov. 24, 1845—John Beatson Bell, Esq., in the Chair.

The following communications were made :—

"*Description and Drawing of a new Rifle Breech.*" By Mr. Thomas Mould, gunmaker, Stirling. Communicated by Mr. Burns of Garvald. Mr. Mould's method is to attach two spiral "ribs" to the breech only, for about two inches where it screws into the barrel, and not to the barrel itself, as in the common method; the ribs being made to describe a curve equal to a whole turn in twelve inches. The breech, after being finished, is case-hardened. The barrel can be made much longer on Mr. Mould's plan without danger of stripping the ball. After firing with this rifle, the tract of the ball can be clearly seen running in a spiral direction along the inside of the barrel, if the breech be unscrewed, and the barrel be held like a telescope. The piece is also said to be much easier loaded. Referred to a Committee.

"*Description and Drawing of a Railway Alarum*", by which the guard may communicate with the Engineer. By Mr. Andrew Carrick. This proposal is for a communication to be effected from the locomotive all along the train by means of rods passing beneath each carriage, which are united by chains after the carriages are attached to each other. On the guard pulling the lever attached to this, a bell is struck on the locomotive so as to give warning to the engineer when any thing is wrong, or when it is wished to stop the train.

"*Description and Drawing of a Railway Indicator,*" for showing at night, or in dense fogs, the speed of the engine, or distance it has travelled from the station. By the Same. This indicator consists of a screw working into a pinion on the axle of the driving wheel, which carries a spindle that works by means of a train of wheels, upon one that carries a hand or pointer, showing how many miles the engine has travelled from the station. Mr. Carrick recommends that, at each station, the engineer sets the pointer to zero, and thus he will know almost exactly where the train is, even in the darkest night or in dense fogs.

"*Description and Drawing of another Railway Indicator.*" By the Same. This is another form of the indicator. It consists in having studs fixed along the railway at each mile, which on the engine passing over them, come in contact with a bell crank, and ring a bell fixed on the locomotive. The engineer can thus count the number of miles passed over.

Monday, December 8.—John Beatson Bell, Esq., V.P., in the Chair.

The following communications were made :—

Notice relative to the properties of

Patent Intonaco Cement, with illustrative specimens. By Mrs. Margaret Henrietta Marshall, Millport.

It was stated that the principal claims to notice possessed by this cement, are its cheapness, hardness, and durability, and the almost boundless variety of purposes to which it may be usually applied. That in architecture, it is alike fitted for walls, flooring, ceiling, and pointing slates, which it unites into one solid immoveable body. That it sets in a few hours, and dries so rapidly, that a house plastered with it may with perfect safety be inhabited in eight days. That it is alike hard through its whole substance; and, even as exterior cement, in imitation of stone, has remained uninjured and unaltered in all weathers, never having been known to peel or throw off any salt from the surface. That it is such a slow conductor of heat, that iron of equal thickness, exposed to equal degrees, showed a balance of 6¼ in favour of the Intonaco, consequently it offers a very great security from fire. That as it shows at least as great a power of resisting damp, lathing may be entirely dispensed with, wherever it is used as wall plaster; and partitions formed of it, according to the plan of the patentee, only two inches in thickness, present a much firmer body, and more effectual deafening, than the 4½ inch double lath partitions at present in use; besides being cheaper;—and that no vermin of any description can penetrate or lodge in walls or partitions done with it. That this cement offers a perfectly new art of imitating marble, which, immoveably united to the surface of sandstone, and highly polished, will bear exposure to any weather. Every style of ancient ornamental flooting can be imitated to perfection at moderate cost. That it forms an entirely new ground either for mural, or easel oil painting: the finished paintings possessing all the advantages of fresco, united to greater depth and brilliancy, and incalculably greater ease of execution. That as a ground for gilding, it has received the highest approbation of practical men; and is ready for the gold in 24 hours after moulding or model.

Account of Experiments on Electro-Culture.—By Andrew Fyfe, M.D., F.R.S.E., Professor of Medicine and of Chemistry, University and King's College, Aberdeen.

In this paper the results of trials on the application of electricity to vegetation, as recommended by Dr. Foster, were first stated, the wires being applied to cabbages, &c. In these experiments Dr. Fyfe did not find the slightest benefit to accrue. At the time that the trials were in progress, experiments were also instituted with the view of ascertaining whether there was an electric current along the wire, which was done by the use of the gold leaf electrometer, and by delicate galvanometers. In all of these, there was not the slightest indication of electric current.

Dr. Fyfe's paper afterwards gave the results of trials on the application of galvanic electricity, this agent being applied in a variety of ways, to peas, beans, onions, potatoes. In some of these the galvanism was applied by sinking metallic plates in the ground, and connecting them with wires, sometimes sunk in the earth, at other times left above it, and in contact with the plants. In other trials the galvanism was applied by the use of batteries, with which galvanometers were connected; the trials, in some cases, being continued for several weeks. In all, not the slightest difference could be observed between the products of the galvanised and non-galvanised vegetable. In the case of the potatoes the products were, in one trial, as 37¼ for the galvanised to 33 for the non-galvanised. In another, it was as 46¼ for the galvanised to 51½ for the non-galvanised. Taking the average of all the trials, the results were as 101½ for the galvanised to 105 for the non-galvanised.

From the results of his numerous trials, Dr. Fyfe concluded that no benefit whatever was observed to follow the application of electricity, either by the mode recommended by Dr. Foster, or by galvanic electricity—at the same time, he stated, that though in these trials no benefit resulted, he was far from asserting that electricity would not be found beneficial; the subject was worthy of prosecution, and he hoped that others would be induced to prosecute it, and to give it the scrutiny to which it was entitled.

ATMOSPHERIC TRACTION.

The power employed in exhausting the Main Pipe compared with the power exerted by the Train Piston; Friction and Leakage being disregarded in both cases.

I presume that Mr. Haydon's formulæ* are general ones, i. e. independent of the dimensions of the tubes and pumps, as likewise of the length of the stroke of the pump and the number of the strokes; and that consequently I may assume, *for the purpose of explanation*, any dimensions, &c., which I find most easy to deal with, however extravagant such dimensions may otherwise appear.

The preliminary exhaustion I will suppose to be effected by means of a piston placed within the main pipe itself. To produce the degree of exhaustion assumed by Mr. Haydon, viz: one third of the atmospheric pressure, or 5lb. per square inch, such piston must obviously be moved along two-thirds of the length of the main; its motion terminating at the end opposite to that from which the train piston is to start.

The power, necessary so to move this piston, may be estimated as follows, (taking each side separately and considering only the effect upon one square inch).

Call the length of the main a, call $\frac{2}{3}$ of its length b, and $\frac{1}{3}$ of its length c, then $a = b + c$.

Opposed to the motion of this piston, through b, there would be the constant atmospheric pressure of 15lb = 15 b.

Assisting its motion throughout b, there would be a pressure varying from 15lb at the commencement, to 5lb. at the termination: if we call the *average* of this varying pressure x, then the assisting force would be $x\,b$, and the general expression of the resistance is 15 $b - x\,b$, or $(15 - x)\,b$, to be overcome in effecting the preliminary exhaustion down to 5lb pressure per square inch.

The train piston being now ready to start, the next object is to maintain in front of it, while it travels, the degree of exhaustion just specified, viz.: 5lb per inch; and for this purpose, I will suppose a second piston to be placed also within the main pipe, at a point some little in advance of the train piston, and that the power by which it (the second piston) is to be moved along the main, is so regulated as to draw it along exactly at the same rate as that at which the train piston itself travels, whereby the space between the two, may not become larger or smaller, as that, if it occurred would change the degree of exhaustion in front of the train piston.

The power necessary to move this *exhaustion maintaining* piston may be estimated as follows:

It must move through a, (the length of the main): opposed to its motion there would be a pressure at the outset of 5lb, but by the time the piston had moved through $\frac{2}{3}$ of the length of the main (or b) the pressure would have increased to 15lb. This varying pressure being precisely equal in continuance and intensity to the assisting pressure of the preliminary exhaustion, its *average* may like that be called x, and its total $x\,b$.

* Part 98, page 335.

This piston must be further moved through the remaining $\frac{2}{3}$ of the length of the main (or c) against an opposing pressure of 15lb $= 15\,c$, the sum of the opposing force is therefore $x\,b + 15\,c$.

To assist its motion there would be a pressure of 5lb throughout the length of the main $a = 5\,a$. The general expression of the resistance of this piston is therefore $x\,b + 15\,c - 5\,a$; and for both pistons $(15 - x)\,b + (x\,b + 15\,c - 5\,a)$ or $15\,(b + c) - 5\,a$: But $(b + c)$ being equal to a, therefore $15\,(b + c) - 5\,a = 15\,a - 5\,a = 10\,a$.

The power operating upon the train piston is $(15 - 5)\,a = 10\,a$; therefore, (leakage and friction excepted,) no power is lost.

It may be thought necessary to enquire, whether, if an air-pump be used, this reasoning still applies.

To take the secondary exhaustion first, I think that Mr. Haydon's formula is just as applicable to the supposed piston, as it is to that of the air-pump; as each stroke of the pump would be merely a diminished representation of the one long stroke of the supposed piston.

In respect of the preliminary exhaustion, it is most easy to form a judgement by making a calculation of the effect of one or more strokes of a pump of dimensions assumed with reference to convenience of calculation only. For instance; we may assume that the pump has twice the capacity of the main, in which case it would effect the preliminary exhaustion by *one upward stroke*. The power necessary to effect this stroke may be estimated as follows: The opposing power is $2\,a \times 15$. The necessary power is therefore $(2\,a \times 15) - (2\,a\,x) =$ The assisting power $2\,a\,x$, $(15\,x) . 2\,a$. And as $a = \frac{3\,b}{2}$, the power is $(15 - x) . \frac{(3\,b \times 2)}{2} = (15 - x) . 3\,b$.

Now as upon the other supposition the preliminary exhaustion of the main was found to require a power $= (15 - x)\,b$, there would be a loss in using the pump of $(15 - x)\,2\,b$; but this amount represents exactly the power consumed in exhausting the cavity of the pump itself, which by the supposition is twice the size of the main.

In my last communication I stated that the only loss (disregarding leakage and friction) was that of the power employed in exhauting the pumps and branch pipes; and the above reasoning confirms that view of the matter.

I may observe lastly that, with small pumps and branch pipes, this loss cannot bear more than an insignificant proportion to the whole power expended.

It has been argued that atmospheric traction is like traction by means of a highly elastic rope, which requires to be stretched, at the expense of much power, before it becomes rigid enough to overcome the resistance of the load, and which being so stretched, is assumed to afford no advantage over an ordinary rope.

Now it would be easy in this case to adopt an arrangement which would recover all the power employed in stretching the rope†. And in the case of atmospheric traction a mere glance at the subject shows that such a recovery of power must take place; for otherwise, the preliminary exhaustion being analogous to the stretching of the rope, the subsequent exhaustions, to complete the analogy, must require as much power as would be sufficient to drag along the train piston by means of a rigid medium; *i. e.* a power equal to that of the train-piston itself! a proposition all but self-evidently erroneous. The power acting upon the train-piston as previously shown being constantly $15 - 5 = 10$; while the resistance to the air-pump piston is 10 through one third only of its stroke, with an average of *about* 3 *during* the remaining two thirds of its stroke, making a total resistance equal to *about one half* of the power acting upon the train-piston.

E. H.

[We have to thank our correspondent for taking great pains to investigate the subjects of certain papers in this journal, and for communicating his observations in a most obliging manner. We cannot, however, carry our courtesy so far as to assent to his conclusions. His arrangement of a supposititious "exhaustion maintaining piston," "some little in advance of the train-piston," is wholly different from anything that occurs in practice. It does not appear how this exhaustion maintaining piston is itself to be moved—not by stationary air-pumps, for the degree of vacuum in front of it is supposed to constantly diminish, until the air actually recovers its natural density; and this could only take place on the supposition that the air-pump *ceases working* directly the train starts.

The mere consideration, that in the air-pump the air is alternately dilated, and condensed, ought of itself to shew that some power is lost, independently of leakage and friction. If the particles of air be at constant intervals moved closer together, and farther apart, than they are in their natural state, it is clear that *force* must be absorbed for the purpose. For to suppose that an elastic fluid has the power of contracting and dilating itself is to indue inert matter with an inherent power of motion.

The principles assumed in Mr. Haydon's paper were so entirely in the ordinary *routine* course of mathematical investigation, that no mathematician would dream of disputing the *nature* of the loss exhibited; all that can possibly be done is to question the *amount*. If our correspondent wish to do this, he must do it not as here, indirectly, but by directly showing some error in Mr. Haydon's paper. He must make no supposititious arrangements of pumps and pistons, but must follow the method of the paper in question, by taking the dimensions of the pump and tube, and the number of strokes to be *exactly what they are in practice*.

The illustration of the man drawing a weight from a well is accurate enough, except that the man's journeys would be less and less each time, while the stroke of the air-pump is always of the same length; the consequence would be that in the former case the loss of power might be made much less than it could possibly be in the latter. Our correspondent himself says, that there would be *some* loss in the former case,—that the power usefully applied would never exactly equal the power expended; the question therefore is, as we said, not one of principle, but a question of mere amount.]

† Suppose a weight is to be raised from the bottom of a well 100 feet deep, by means of an elastic rope 100 feet long, passing over a pully at the top of the well, and being drawn along horizontally by a man. Suppose the man found the rope to stretch to double its length; i. e. to 200 feet, by the time it began to lift the weight. Being so stretched, let its upper end (the 100 feet from the well head) be secured upon the ground, (by spiking or otherwise); and let the man then take hold of the rope close to the well head; the slightest force applied there will make the weight begin to rise; because the man has in his favour the reaction of the half of the rope which lies behind him, but as the weight rises, this half of the rope will shorten, and its reaction will diminish constantly till it ceases just when the man has moved 50 feet from the well head, raising the weight 50 feet.

In this operation however one half of the power, originally employed in stretching the rope, will have been recovered.

In like manner let the man make fast upon the ground the part of the rope which he now holds,—go back to the well head, and draw the rope forward 25 feet, raising the weight 25 feet; and he will further get back one quarter of the said power.

He may regain $\frac{1}{8}$ $\frac{1}{16}$ $\frac{1}{32}$ &c. so long as he goes on; whereby he may regain all b infinitesimal fraction.

THE PROPOSED EXPOSITION OF MANUFACTURES AND INDUSTRIAL ART.

The preparations for the proposed exposition of Manufactures and Industrial Art, in connection with the Manchester School of Design, under the direction of our talented townsman, Mr. George Jackson, are in a forward state, and the exhibition will be ready for the Christmas holidays. Mr. Jackson and his colleagues are gentlemen fully competent to the task they have undertaken, and their success so far has even exceeded their anticipations. It is now expected that every nook and corner of the Royal Institution will be required for the display of the articles, so numerous will they be. From the answers already received, it is expected that the contributions from the Potteries will be rich, indeed magnificent—several houses of eminence in the china trade having promised contributions of the highest class, and of considerable amount. From Stourbridge and Birmingham they have promises of an extensive collection in glass, comprising chandeliers and articles of general utility; and from the latter place there will be a considerable quantity of japanned goods, brassworks, and manufactures of other descriptions peculiar to the town. There will also be some very brilliant specimens, both in gold and silver, of the electro-deposit. From Coventry splendid specimens of ribbons and gauzes will be forthcoming, and watches equal to anything of foreign production. From Leicester a display of hosiery; and from different places in Nottingham a splendid collection of laces are promised. Sheffield is to contribute specimens of its steel and other goods, comprising grates, fenders, fire-irons, cutlery, &c. Glasgow is under contribution for carpets, and some magnificent articles of large dimensions woven in one piece are amongst the specimens. From Paisley, shawls, scarfs, and other woven fabrics peculiar to the district are bespoken. From Ireland specimens of linen are to be exhibited, manufactured from Irish-grown flax. London is to send silversmiths' goods, including splendid specimens of plate; and some magnificent collections of testimonial plate are on their way to Manchester from thence. Among the manufactures of our town an effort is making, and the contribution will include a large collection of printed cottons, de laines, and silks. The exposition of the latter description of goods will also include silks from Macclesfield, Spitalfields, and other places. The Council, we learn, have not restricted the exposition to articles of home manufacture only, but have induced several foreign houses to exhibit and forward specimens of their manufacture. As a favourable sample of the spirit in which they have been met on this point, we may mention that one house in London declined answering the application till a partner in Paris had been consulted. His reply was not very favourable, but he added, that in his opinion the Council had adopted "a principle with regard to this exposition that ought long ago to have been adopted on the continent, in allowing the foreigner to exhibit in competition, and that the expositions on the continent would never be successful till they adopted the same principle." The Council, however, confine the exhibition to the production itself, and do not contemplate exhibiting, as at the Parisian exposition, the means of production. With regard to the School of Design itself, it is expected that on this occasion it will fully bear out the anticipations which the public have been led to draw, and that the specimens will show the utility of such institutions like this, where they can be properly conducted. We are also glad to find that the prizes offered by the Council, to stimulate designers of the town generally, have had a good effect; and that the drawings sent in for competition are numerous, and many of them talented.—*Manchester Times.*

RAILWAYS NOW AT WORK IN THE UNITED STATES,

(Together with the length of each railway in miles.)

Maine, New Hampshire, Massachusetts.
Portland, Saco, and Portsmouth, 50 m.
Concord, 35 m.
Boston and Maine, 56 m.
Boston and Maine Extension, 17½ m.
Boston and Lowell, 26 m.
Boston and Providence, 41 m.
Boston and Worcester, 44 m.
Berkshire, 21 m.
Charlestown branch.
Eastern, 54 m.
Fitchburg, 50 m.
Nashua and Lowell, 14½ m.
New Bedford and Taunton, 20 m.
Northampton and Springfield.
Norwich and Worcester, 59 m.
Old Colony.
Stoughton branch, 4 m.
Taunton branch, 11 m.
Vermont and Massachusetts.
West Stockbridge, 3 m.
Western (117 miles in Mass.) 156 m.
Worcester branch to Milbury.
Housatonic, (10 months,) 74 m.
Connecticut.
Hartford and New Haven, 38 m.
Hartford and Springfield, 25½ m.
Stonington (year ending Sept. 1) 48 m.
New York.
Attica and Buffalo, 31 m.
Auburn and Rochester, 78 m.
Auburn and Syracuse, 26 m.
Buffalo and Niagara, 22 m.
Erie (446 miles).
Erie, opened, 53 m.
Harlem, 28 m.
Hudson and Berkshire, 31 m.
Long Island, 96 m.
Mohawk and Hudson, 17 m.
Saratoga and Schenectady, 22 m.
Schenectady and Troy, 28½ m.
Syracuse and Utica, 53 m.
Tonnawanda, 43 m.
Troy and Greenbush, 6 m.
Troy and Saratoga, 25 m.
Utica and Schenectady, 78 m.
New Jersey.
Camden and Amboy, 61 m.
Elizabethtown and Somerville, 26 m.
New Jersey, 34 m.
Paterson, 16 m.
Philadelphia.
Beaver Meadow, 26 m.
Cumberland Valley, 46 m.
Harrisburg and Lancaster, 36 m.
Hazleton branch, 10 m.
Little Schuylkill, 29 m.
Blossburg and Corning, 40 m.
Mauch Chunk, 9 m.
Minehill and Schuylkill Haven, 18 m.
Norristown, 20 m.
Philadelphia and Trenton, 30 m.
Pottsville and Danville, 29½ m.
Reading, 94 m.
Schuylkill Valley, 10 m.
Williamsport and Elmira, 25 m.
Philadelphia and Baltimore, 93 m.
Delaware.
Frenchtown, 16 m.
Maryland.
Baltimore and Ohio (Oct. 1), 188 m.
Baltimore and Susquehanna, 58 m.
Baltimore and Washington, 38 m.
Virginia.
Greensville and Roanoke, 17½ m.
Petersburg and Roanoke, 60 m.
Portsmouth and Roanoke, 78½ m.
Richmond, Fredericksburg, and Potomac, 76½ m.
Richmond and Petersburg, 22 m.
Winchester and Potomac, 32½ m.
North Carolina.
Raleigh and Gaston, 84 m.
Wilmington and Raleigh, 161 m.
South Carolina.
South Carolina, 136 m.
Columbia, 66 m.
Georgia.
Central, 190½ m.
Georgia, 147 m.
Montgomery and West Point, 89 m.
Kentucky.
Lexington and Ohio, 40 m.
Ohio.
Little Miami, 40 m.
Mad river, 40 m.
Indiana.
Madison and Indianapolis, 56 m.
Canada.
Champlain and St. Lawrence, 15 m.

FITZWILLIAM MUSEUM.

The Syndicate appointed to report on the state in which the designs for the building are left, and of the engagements made with the contractors for the execution of the work, have reported as follows :—

"The Syndicate find by an examination of the drawings left by Mr. Basevi (which have been sent for their inspection by his brother, Mr. N. Basevi), that the designs for the greater part of the work remaining to be executed are in a forward state, but they conceive that these designs not having been perfected, require, for the completion of the work, the assistance of an architect of the same order as Mr. Basevi in professional eminence and skill.

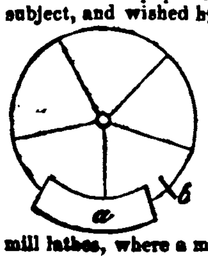
"The Syndicate think it highly desirable that the building should be completed with a close adherence to Mr. Basevi's intentions, so far as they appear in a settled form in his designs.

"The Syndicate have also ascertained, by inquiry of Mr. N. Basevi and Mr. Baker, the state of pending engagements with Mr. Baker, and the results of this inquiry will be laid upon the registrar's table.

"The Syndicate, considering the high professional character of Mr. Cockerell, and the confidence already reposed in him by the University, beg leave to recommend that Mr. Cockerell be appointed Mr. Basevi's successor as architect of the new Fitzwilliam Museum, with instructions to adhere as closely as may be to Mr. Basevi's designs in carrying on the work to its completion."

In accordance with that report a grace passed the Senate to appoint Mr. Cockerell architect of the Fitzwilliam Museum, in the room of the late lamented Mr. Basevi.

Newcastle Philosophical Society.—An excellent paper has been read by Mr. Armstrong (the inventor of the hydro-electric machine,) on the application of water pressure as a motive power, to be supplied from street mains. The lecturer illustrated his remarks by a model of a crane for lifting heavy weights, and he had the complete control of the motive power, and speed for raising, lowering, or turning round variable loads. He referred to a paper in the Mechanic's Magazine of April, 1840, on the subject, and wished his claim of priority of application of this power to be confirmed. The mechanical arrangement was very perfect. The lecturer exhibited also a machine for circular motion ; *a* a curved pipe, with water pressure beneath ; *b* a circular disc, or piston, with others similar to it, arranged at equal distances in the periphery, and they are, like the reefing paddles, made to enter edgeways into the curved pipe, and to turn transverse to act as pistons ; each successive piston entering before the preceding leaves the curved pipe. The machine is applicable to copper-mill lathes, where a motive power of amount is required at intervals, and the cost of power is estimated at only one-third the cost of manual labour.



MISCELLANEA.

Astronomical Observations.—A parliamentary document has just been printed, in answer to a return of Mr. Hume, for a copy of instructions to astronomers of the several observatories at home and abroad in the year 1837-8, with the number of volumes of astronomical observations made at each observatory since that year. It appears that no instructions were sent by the Board of Admiralty to the Astronomer Royal in 1837-8. One volume of astronomical observations is printed in each year by the Royal Observatory. A report is annually made in the month of June to the Board of Visitors by the Astronomer Royal on the state of the observatory, and communicated to the Board of Admiralty. It is added, that at the Royal Observatory at the Cape of Good Hope no astronomical observations have been printed since the year 1838, the astronomer and his assistants having been chiefly employed in the measurement of an arc of the meridian. Different volumes of astronomical observations made at Greenwich and elsewhere have been printed since 1837, under the superintendence of the Stationery-office.

St. Mary's Church, at Beverley.—A local paper says that the restorations of this fine edifice are progressing satisfactorily, and the work already executed is done in a substantial manner. A barrel drain of sufficient dimensions has been laid at a considerable depth round the church, which proves very efficient in keeping not only the floor of the nave and chancel, but the whole building perfectly dry. The flagged area and parapet wall, and the approaches to the five entrances, are finished. The foundations of the fabric have been carefully examined, and the basements of the buttresses, the walls, and their respective weather mouldings, repaired and restored to a considerable height; so that the stability of the structure may so far now be considered as secure as when first erected. The interior of the crypt is being proceeded with, and what has for ages seemed only a miserable-looking cellar, choked up with accumulations of soil, and bones and debris of every kind, already assumes a handsome appearance.

Present of Medieval Antiquities to the British Museum.—We understand that Lord Prudhoe, anxious for the formation, in England, of a public national collection in illustration of national antiquities, and persuaded that the British Museum is the best and most extensively available place of deposit for such a collection, has made an offer on subject to the Archæological Institute,—whose authority in such matters he desires to recognize and reserve. He proposes, we believe, to present to the Museum, through the medium of the Institute, and as a result of the meeting at Winchester, his collection o remarkable antiquities which were exhibited in the Museum on that occasion,—on condition that the trustees shall undertake to set apart a proper place for collections of the kind. Such is the report in antiquarian circles ; and we have reason to believe that the example of Lord Prudhoe has already been fruitful in other offers of a similar kind, in the event of the arrangement which is its condition taking effect. We have little doubt that a proposal of the kind will determine an arrangement for a separate assemblage and exhibition, in our great national institution, of the works of British and Mediæval Art : and the influence of the Institute will then have been early felt, in the formation, through their means and authority, of a department which has been so long felt to be a necessary feature of such an establishment. At the same time the Institute has no intention, while ministering to their larger object, to abandon the formation of similar collections for itself. Contributions to its library are, we are glad to hear, rapidly coming in ; and one of its projects is to take advantage of the opportunities afforded by its extended correspondence, in the collection of materials for local history. A large number of impressions from sepulchral brasses have also been presented ; and the Society purposes, we believe, to form, if possible, a complete collection of these memorials, for the sake of their valuable testimony on subjects of costume, family history, heraldry, and other antiquarian subjects.—'Athenæum.'

It is reported that an experimental squadron of steam vessels will put to sea to try their respective rates of sailing and steaming, and other features, as efficient and serviceable vessels of war, early in the ensuing spring, and that gunnery exercise will be a leading item in their trials, in order to ascertain which armament is best adapted for vessels of their class. The competing vessels named are the—

Vessel.	Tons.	Horse Power.
Terrible	1,847	800
Retribution	1,641	800
Avenger	1,444	650
Gladiator	1,167	4[illegible]0
Sampson (frigate)	——	450
Ardent (sloop)	——	200
Rattler (screw)	888	200
Scourge	1,124	420
Black Eagle	495	260

Early Painted Decorations.—Some curious remains of the early art of painting, as practised in England, have been lately brought to view, at Southerop, in Gloucestershire. The chancel of the parish church, of the Anglo-Norman era, requiring restoration, on removing the accumulated coatings of whitewash from the walls, it was discovered that it had been at one time a perfect gallery of scriptural and other subjects, not the smallest portion, from the roof to the floor, having been left unadorned. Most of these quaint designs were too far advanced in decay to be deciphered; but the Nativity, the Annunciation, and the Decapitation of St. John the Baptist, are still apparent, and show that the recluse and devout designers possessed all then known of art, as well as all the learning of the time. A remarkable device for the decoration of a sacred edifice remains in one of the deep recesses of the lancet shaped windows; it is the figure of a month, in a red tunic, shooting an arrow at a red squirrel in a bright yellow tree, the bow held in the right hand. The costume of this figure seems to make the date somewhere about the middle of the fourteenth century—five hundred years since.

Valuable Discovery.—A French mechanic formed the idea that by subjecting iron dross to the slow cooling process which is known to produce a total change in the nature of glass, a new and useful species of stone might be obtained; and as iron-dross, such as the large furnaces yield, is a wholly useless substance, the announced successful result of his persevering attempts cannot but be matter of great interest, more especially at the present time, when the smelting furnaces of England are in a hitherto unknown state of activity. The object which the Frenchman sought to accomplish was, to impart to iron dross the compactness and hardness of granite, and at the same time to save the cost and labour which the hewing of the real stone requires. To this end he contrived to let the iron refuse, while in a fluid state, run into iron forms, which were previously brought to a red heat by being placed so as to receive the superfluous flame which issues from the mouth of the furnace; and in order to insure the slow cooling, these forms are provided with double sides, between which sand is introduced, which is well known to be a bad conductor of heat; the whole is then brought again to a glow heat, and in like manner again cooled off. By this procedure, it is asserted, the ingenious discoverer has succeeded in forming paving stones, flags, large building block and even pipes, of any given form, of a degree of hardness and polish, equal, if not superior, to the best hewn natural granite, and at the most trifling conceivable cost.

The Iron Trade in America.—By an arrival from New York, on Monday, we have the following interesting particulars relative to the development of the iron trade there:—"The production of iron in Pennsylvania in 1844 was about 200,000 tons and it is estimated that this year it will amount to about 350,000 to 400,000 tons. It is, also estimated from good data that the total production of in the United States this year will not fall short of 700,000 tons, and that the consumption will amount to about 800,000 tons, leaving a deficiency, to be supplied by importation, of about 100,000 tons. We annex a table exhibiting the quantity and value of iron and steel of all kinds imported into the United States for the last sixteen years.

Aggregate Quantity and Value of Iron and Steel imported into the United States.

Years.	Tons.	Value. Dollars.	Per Ton. Dollars.
1828-29	36,314	2,417,292	66
1829-30	40,644	2,340,964	56
1830-31	51,571	2.235.363	49
1831-32	73,979	3,697,380	—
1832-33	80,289	3,371,867	—
1833-34	78,190	3,938,396	—
1834-35	59777,	5 710,193	—
1835-36	96,220	5,859,131	—
1836-37	102,866	6,363,188	—
1837-38	74,762	4,036,963	54
1838-39	115,637	6,688,598	57
1839-40	72,769	4.341,086	59
1840-41	112,111	6,020,416	44
1841-42	107,392	4,332,000	40
1842-43	37,405	1,665,651	43
1843-44	105,277	8,963,833	37
	1,261,074	63,837,526	50

This table shows that, notwithstanding the immense increase in the consumption of iron in this country, there has not been any very great increase in the importation, and that the supplies from our own manufactories have nearly kept pace with the increased demand for consumption.—The most extensive works in this country are those of the Mount Savage Company of Maryland. Its present capital is 1,500,000 dollars, with power to increase it to 5,000,000 dollars. Its stock is owned principally in Europe. These are the only works in the United States where railroad iron is manufactured to any extent, and it is calculated that 20,000 tons can be made in a year. Some of the eastern railroads now building are supplied with rails by this company. The mines of the Mount Savage Company, and in fact all the iron mines of Maryland, are situated in the Cumberland coal region, which, for the manufacture of iron, is said to be superior to any other."

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM NOVEMBER 27, TO DECEMBER 24, 1845.

Six Months allowed for Enrolment, unless otherwise expressed.

John White, of Salford, Lancaster, engineer, for "certain Improvements in engines, machinery or apparatus for raising and forcing water."—Sealed November 27.

Peter Spence, of Burgh, Cumberland, for "Improvements in the manufacture of copperas and alum."—November 27.

Moses Poole, of Searle-street, Middlesex, gent., for "certain Improvements to hinder the oxydation of iron to all its various states of cast metal, steel, malleable iron, and also to render malleable iron more hard and durable." (A communication.)—November 27.

Eden Thomas Jones, of Bristol, manufacturing chemist, for "Improvements in the apparatus used in the concentration of sulphuric acid."—November 27.

William Maugham, of Newport-street, Surrey, consulting chemist, and Archibald Dunlop, the younger, of Upper Thames-street, gent., for "Improvements in the manufacture of ale, porter, and other fermented liquors."—November 27.

Edward Dell, of Woolwich, wine-merchant, for "certain Improvements in apparatus for heating and warming."—December 4.

Robert Rettie, civil engineer, of Glasgow, for "an Improved method of signalizing, or telegraphing on sea or land, preventing collision at sea, and giving signals of distress by improved burners with glasses coloured, and signal cards, applicable to railways in all the various departments, as well as preventing of accidents when the train is at full speed, showing the state of the tide in harbours, also the diurnal for railways, towns, villages, &c."—December 4.

William Gossage, of Neath, metallurgist, for "Improvements in obtaining products from certain ores and other compounds of certain metals."—December 4.

John Leslie, of Conduit-street, Hanover-square, tailor, for "Improvements in the combustion of gas."—December 4.

Moses Poole, of Serle-street, Middlesex, gent., for "Improvements in locks." (A communication.)—December 4.

James Meacock, of Kingston, Jamaica, merchant, for "Improvements in pulping, dressing, and sorting coffee."—December 4.

Archibald Dunlop, jun., of Thames-street, London, gent., for "Improvements in the manufacture of aerated waters."—December 4.

Henry Bessemer, of Baxter House, Old St. Pancras-road, Middlesex, engineer, for "certain Improvements in atmospheric propulsion, and in apparatus connected therewith, part, or parts of which improvements are applicable to the manufacture of columns, pipes and tubes, and other parts are applicable to the exhausting and impelling of air and other fluids generally."—December 5.

John Robert Johnson, Alfred-place, Blackfriars, chemist, for "Improvements in the materials employed in constructing and working atmospheric railways."—December 6.

Henry Heathcote Russell, of Millbank-street, Westminster, civil engineer, for "Improvements in constructing suspension bridges and viaducts."—December 6.

Josiah Wilkinson, of Lincoln's Inn-fields, gent., for "certain Improvements in filtering water and other fluids." (A communication.)—December 8.

Henry Augustus Box, of Great Titchfield-street, St. Marylebone, decorator, for "A new method of polishing, dyeing, and colouring marble, stone, and certain other materials used in the construction or decoration of houses and other buildings."—December 10.

Edward Green, of Wakefield, York, engineer, for "A new method of economising fuel, and certain improvements in retaining and applying heat for generating steam and heating water."—December 10.

Thomas Williams, of Norway-street, Middlesex, gent., for "a certain Improvement or improvements in wrenches or spanners."—December 10.

William Dines, of Oldston, near Dartmouth, Devon, Esq., for "Improvements in the making and fixing window glass."—December 10.

George Mordey Mowbray, of Paternoster-row, London, wholesale druggist, for "an Improved method of communication between the person or persons having the charge of a railway train and the controller of its motive power."—December 10.

Robert William Thomson, of Adam-street, Adelphi, civil engineer, for "an Improvement in carriage wheels, which is also applicable to other rolling bodies."—December 10.

Henry Lawrence, of Wigmore-street, Cavendish-square, gentleman, for "an Improved buckle, suitable for harness and other purposes."—December 10.

George Leach Ashworth, of Rochdale, Lancaster, cotton spinner, and Wilson Crossley, of the same place, manager, for "certain Improvements in machinery or apparatus for preparing and spinning cotton and other fibrous substances."—December 10.

James Garforth, of Dunkinfield, Chester, engineer, for "certain Improvements in machinery or apparatus for connecting of boilers, and other purposes."—December 10.

Alfred Vincent Newton, of Chancery-lane, mechanical draughtsman, for "Improvement in printing and dyeing various fabrics." (A communication.)—December 10.

Christopher Dunkin Hays, of Bermondsey, master mariner, for "Improvements in the construction and adaptation of apparatus for propelling and steering vessels on water."—December 10.

Charles Dowes, of Camden-town, gentleman, for "an Improved paper or material."—December 10.

William Mushet and Robert Mushet, iron founders, of Dalkeith, Scotland, for "Improvements in moulding iron."—December 10.

Thomas Victor Ailler, of Quai Saint Michel, Paris, gentleman, for "Improvements in breaks or machinery for stopping or retarding carriages."—December 10.

Frederick Gye, jun., of South Lambeth, for "Improvements in preparing aerated waters, and in vessels to contain aerated and mineral waters."—December 10.

Moses Poole, of Serle-street, Middlesex, gentleman, for "Improvements in apparatus to be used for drawing and marking." (A communication.)—December 10.

William Mac Naught, of Robertson-street, Glasgow, engineer, for "certain Improvements in the steam engine."—December 10.

Isaac Hawker Bedford, of Birmingham, for "Improvements in the manufacture of window and other glass." (A communication.)—December 12.

Moses Poole, of Serle-street, Middlesex, gentleman, for "Improvements in filling bottles and other vessels, and also in covering, stopping, or securing liquids and other matters in bottles and other vessels." (A communication.)—December 12.

Samuel Cunliffe Lister, of Manningham, York, gentleman, for "Improvements in carding, combing and spinning wool."—December 12.

Thomas Findler, of Flint, miller, for "Improvements in the construction and operation of certain parts of flint-grinding mills, and other grinding mills or machinery for grinding."—December 15.

John Robert Johnson, of Nelson-square, chemist, for "Improvements in purifying gas, and in the treatment of products of gas works."—December 20.

Henry Mandeville Meade, of New York, America, gentleman, for "certain Improvements in the manufacture of bread." (A communication.)—December 20.

George Fergusson Wilson, of Belmont, Vauxhall, gentleman, George Gwynne, of Regent-street, gentleman, and James Pillans Wilson, of Belmont, aforesaid, gentleman, for "Improvements in treating certain inflammable matters, and in the manufacture of candles."—December 20.

William Hannis Taylor, of Piccadilly, gentleman, and Francis Roubillac Conder, of Birmingham, civil engineer, for "certain Improvements in propelling."—December 20.

Jabez Church, of Colchester, gas engineer, for "Improvements in the manufacture of coke, and in the ovens for producing the same."—December 20.

John Blyth, of Limehouse, engineer, for "certain Improvements in diminishing the risk of accidental explosions of gunpowder and other substances which are liable to explode, or ignite by contact with fire."—December 20.

William M'Hardy, of Salford, for "certain Improvements in machinery or apparatus applicable to the preparation and spinning of cotton, wool, silk, flax, and other fibrous substances."—December 22.

Alfred Vincent Newton, of Chancery-lane, draughtsman, for "Improvements in combing wool." (A communication.)—December 22.

Samuel Heseltine, jun., of Bromley, Middlesex, civil engineer, for "Improvements in machinery or apparatus for dressing stones for grinding corn, grain, and other substances." (A communication.)—December 22.

Philip Smith, of High-street, Lambeth, lock-smith, for "Improvements in locks, latches, and other similar fastenings."—December 22.

CORRESPONDENTS.

Mr. Henry Carr, engineer of the Croydon Atmospheric Railway, in consequence of numerous inquiries, is anxious to state that the authorship of certain papers, which have appeared in this journal, with the initials "H. C." appended, is not to be attributed to himself.

Dr. Shoklitz, Limburg, Austria. On examining the invention, it appears to us so very impracticable, that we have not thought it worth while to give an account of it.

Next month, "Presbyterian Church, Dublin," and "Railway Key, Cardiff."

ON LIMES, MORTARS, AND CEMENTS.

From the Report to the Chamber of Deputies of the Commission appointed to consider the propriety of granting a pension for life to M. VICAT, *Engineer in chief, and Superintendent of Bridges and Highways.*

BY M. ARAGO.*

(*Translated from the French for this Journal.*)

Your Committee, from the time of their first sitting, have fully assented to the motive which suggested the proposition on which you are called to deliberate. They felt convinced that in submitting the *great discoveries* of our countrymen to the appreciation of the three constitutional powers of the kingdom, that in having recourse to all the solemnities of the law in regulating the remunerations which inventors may have deserved, they stimulate to the highest degree, and in the most beneficial manner the zeal, the ardour, the perseverance of men of genius.

We speak, solely of *great discoveries*. Respecting extensive works, however admirable in themselves, as this character does not legitimately belong to them, it does not appear our duty to invite the attention of the legislative Chambers.

These considerations mark out distinctly the course which we have to take. We have to examine whether M. Vicat is to be placed among the privileged men whom posterity will hold in remembrance; whether his works, when they came before the public, had the indisputable character of novelty; whether they possess general interest; whether, in fine, the results arising from them ought to take their rank among the brilliant inventions for which our country justly claims honour.

This brief preamble will justify the detailed observations which you are about to hear. We considered that in submitting to analysis the strictest and most minute a merit, so well recognised as that of M. Vicat, we should inspire a salutary distrust in those mediocrities who would have their names resound in this place. If the Commission have attained this end, they will, without doubt, have satisfied beforehand one of the objects of the Chamber.

MANUFACTURE OF HYDRAULIC LIMES.

Lime, whether in a state of purity, or, as is more usual, mixed with other substances, is the material used from the remotest times to bind together stones and all the constituent parts of buildings. If lime be not found in any part of the globe pure, the rocks from which it may be extracted—the calcareous rocks—exist almost everywhere. No mineral is so widely distributed by nature.

It is rare that calcareous stones are entirely pure, or exclusively composed of lime and carbonic acid. Their substance is usually made up of silex, aluminum, magnesia, oxyde of iron, manganese, &c. Thence the terms adopted by mineralogists of argillaceous, magnesian, ferruginous, or manganesian limestones.

These limestones furnish by roasting very different limes. Builders distinguish many kinds of them—rich lime—poor lime—hydraulic lime. Rich lime increases greatly in bulk when slaked; its weight is then more than doubled. This property would be very valuable in respect of economy did not rich limes remain a long time without hardening, especially in the centre of masonry, and particularly where they are kept from the action of the air; rich limes, moreover, are dissolved to their last particles in water frequently renewed; this solubility of the lime in time converts masonry into mere heaps of stones: quay-walls, for instance, which have been supposed to have been built of strong masonry, and with the greatest solidity.

Is it necessary to cite examples to shew that the rich limes will not harden without the action of the air? We may point to the fact that M. Treussart having had to reconstruct in 1822, at Strasburg, the foundations of a bastion built in 1666, found there the mortar as fresh as if the masons had laid it some few hours before. A similar circumstance was observed at Berlin by the architects who took down one of the pillars of the tower of St. Peter, built about 80 years ago.

Are we required to shew that the constant action of water dissolves rich limes in masonry? We choose among a thousand examples the demolition of the remains of the ancient sluices of the Vilaine. During this operation, it was found that, by the dissolving of the rich lime, there remained behind the revetement walls nothing but masses without cohesion, simple heaps of loose stones.

Poor or thin lime has all the defects of rich lime, and moreover, as its name indicates, but slightly increases in bulk. The use of it is therefore, as much as possible, avoided.

* Notices of M. Vicat's hydraulic lime, for resisting the action of water, will be found in the first volume of this journal, p. 4, and in vol. VI., p. 229.

Builders who desire to make their works lasting, must employ exclusively hydraulic limes, especially for foundations resting on a damp soil.

Hydraulic limes are those which readily harden under water. This property does not develop itself always in the same degree. The most valuable hydraulic limes begin to set the second to the fourth day after immersion; at the end of a month they are hard and quite insoluble; in the sixth month they assume the nature of certain *limestones*, a blow breaks them with a sharp sound, and the fracture has a laminated appearance.

The natural limestones are not distinguished in general from each other by any particular physical character of their texture, hardness, specific gravity, or colour, which will enable us to predict what kind of lime they will furnish. The rich, the poor, and the hydraulic limes are imperfectly white, grey, fawn-colored, red, &c. It is in the internal composition of rocks, in the nature and proportion of their constituent principles that the chemists have sought the real causes of the power of hardening under water (*hydraulicité*).

It has been long proved that the most pure limestones, the statuary marbles, primitive or saccharoid, the marbles of Paros and Carrara, always give by calcination the rich lime; it is also well known that the property of hardening under water is communicated to lime by particular substances contained in the material of the calcareous rock from which the lime is made. But what are these substances, and in what proportion ought they to exist in the limestone, to produce the requisite property in a sufficient degree? On this point opinions have long been divided.

Bergmann (for the greatest chemists have occupied themselves with the question,) attributed the characteristic properties of hydraulic limes to the presence in them of a small proportion of the oxyde of manganese.

Guyton-Morveau adopted the idea of his illustrious friend. It was evident, nevertheless, that the hypothesis did not afford a general solution: there are known to exist natural hydraulic limes in which there is no trace of the oxyde of manganese. It has even been stated that this oxyde does not possess the property assigned to it. A sluice constructed in Sweden, according to the notions of Bergmann, with a mortar composed of rich lime and manganese, was found so defective that it was necessary to destroy it a very short time after it was constructed.

The earliest investigations which we are acquainted with on the composition of hydraulic limes, date from the year 1756, that is, from the epoch when Smeaton proposed for bold task of building the Eddystone lighthouse. This great engineer then examined with the most scrupulous care the natural hydraulic lime of *Aberthaw*, Glamorganshire. This lime had in England a certain celebrity. Treated by acids, it left a residue "which *appeared* to be a bluish clay, weighing about $\frac{1}{8}$th of the total weight of the stone." The reddish colour which this residue acquired by roasting, induced Smeaton to think the calcareous rock of Aberthaw (it was already called *lias*) contained *iron*.

Saussure published in 1786, in the second volume of his celebrated travels, some observations tending to attribute the hydraulic property of the limes of St. Gingoulph, in Savoy, to the combined influence of manganese, quartz, and even clay, contained in the calcareous rocks of that locality. It must be added, for the sake of accuracy, that the illustrious naturalist leaves his opinions in the form of simple conjectures.

One more citation, and we shall have gone over the whole of the researches which preceded those of M. Vicat.

M. Collet-Descostils, Engineer of mines, having, in 1813, discovered a remarkable quantity of silicious matter in a very divided state in the lime of Senonches, attributed to the presence of silex, the hydraulic property, which is so energetic, and well known in this lime.

What was wanting in the conjectures of Smeaton, of Saussure, of Descostils? They wanted that which transforms simple conjecture into incontestible principles; they wanted the precision and clearness, the never-failing marks of established truths; they wanted to be resolved and simplified—to pass, in a word, by the impulse of a powerful hand, from the vague cloudy region of reveries into the place of practical truths.

In his first essays M. Vicat made use of synthesis; every one who had remarked how much the crystalline or nolecular condition modified the physical properties of certain bodies could not attach, but a limited confidence in the advantages to architecture likely to proceed from the chemical analysis of limes. The experiments of M. Vicat were directed straight to the object in view.

The natural limes of Senonches were the type of perfection. M. Vicat composed an *artificial* lime, superior to that of Senonches. He obtained this great result by calcinating, in proper proportions, chalk or pure lime, mixed with clay. By this experiment light succeeded to obscurity, certainty to doubt; the art of building had received the accession of an *admirable discovery*.

We do not suppose that this merit can be contested. We cannot believe that the desire, unfortunately too common, of robbing a contemporary of honor to the profit of the dead, will influence any one to exaggerate the value of the essays, hypotheses, and conjecture, previous to the labours of the engineer of the bridge of Souillac. It may be proved incontestibly that M. Vicat is not less really the discoverer in the subject of hydraulic limes than Newton was when he published the Theory of the Composition of White Light, or than Franklin was when he proposed lightning conductors to the civilised world. The great Smeaton essayed fruitlessly to render the rich lime hydraulic by the addition of clay without preparation; Smeaton mistaking, after repeated trials, the necessity of *roasting* the clay, showed, moreover, more clearly than all reasoning could do, the immense distance which separates simple appearances from realised and complete discoveries.

M. Vicat has carried out his felicitous investigations in all respects relating to the uses to which lime is appled in masonry; the art of burning lime, of dispelling, in the most effectual and economic manner, the carbonic acid, one of the constituents of calcareous rocks, is indebted for important remarks to the labors of our celebrated engineers; after the precise directions which these labours explain, there can be no hesitation as to the methods to be adopted to foresee at once what will ultimately be the qualities of any given samples of lime. To understand the processes which must be followed to slake limes of different sorts, we may consult with much profit the result of the experiments of M. Vicat; the choice of the materials which unite with limes of all kinds to form mortars will no longer be a matter of blind routine.

The necessity of being concise compels us to mention merely under this head the interesting researches of M. Vicat. We suppress, for the same reason, the analysis of the refined theoretical considerations, by the aid of which our engineer explains the gradual and prolonged action of limes on the substances with which they are combined in the mixing of mortar. We regret also to be compelled to refrain from the agreeable task of rendering full justice to the admirable experiments of M. Berthier, one of the best chemists of whom France can boast.

Cements.

M. Vicat has occupied himself with equal success in investigating the properties of *cements*.

Architects distinguish cements from mortars by their natural appearances. The sand contained in *mortar* exists there in the form of gravel more or less coarse, and more or less apparent. The composition of *cement* appears homogeneous, although it contains lime, silex, and alumina.

No substance has gained more celebrity among builders than that known at the present day as *Roman Cement*. This cement, called originally *aquatic cement*, was made in the year 1796 by Messrs. Parker and Wyatt. It was the result of subjecting to heat certain nodules of limestone of an ovoid form found in great abundance at some distance from London. Roman cement, mixed rather thick, solidifies in a few minutes either in air or water. There are certain works, the Thames Tunnel for instance, which could not have been executed without Roman cement. Under other circumstances this rapid solidification is a real obstacle; and in such cases it is necessary to substitute hydraulic lime, of which the price is much less.

Parker and Wyatt manufactured their cement, and found a sale for it throughout Europe; builders used it, but no one took notice of the real cause of its singular properties. The discovery of this cause belongs incontestibly to M. Vicat. We find, in fact, that after having indicated the proportion of clay which renders lime hydraulic, the skilful experimenter published in 1817 this categorical observation—

"When we increase the proportion (of clay) to 33 or 40 per cent., we obtain a lime which does not slake; but it pulverises readily, and produces, when wetted and mixed up, a composition which quickly sets under water."

The proportion of clay indicated is precisely that of the substance manufactured by Parker and Wyatt. M. Vicat made, then, from 1817, every kind, not only of hydraulic lime, but also of Roman cement.

The duty assigned to your Committee does not permit the citation of facts purely scientific; they therefore desire to remark that the discovery of our engineer respecting cements comes, in a great measure, under the description of practical applications. Here, as in the case of hydraulic limes, and as in other cases to be explained hereafter, geology, enlightened by M. Vicat as to the industrial value of limes containing a large quantity of clay, has directed its attention to these useful investigations, and the French builders, not long since dependent on England, have discovered a great number of places where they can prepare Roman cement. M. Vicat himself has pointed out more than 400. This new branch of industry is carried on with much success in many departements of France.

If the limits of this Report permitted, we could mention here many persons who have deserved great credit by the discovery of quarries of Roman cement, and, among others, a skilful engineer, whom the Chamber of Deputies reckons among its members, M. Lacordaire.

Pozzolanas and Tarras.

The natural pozzolanas, in the hands of ancient architects, tarras in the hands of mediæval architects, have played too important parts to have escaped the attention of M. Vicat. Despite all the difficulties of the subject, success, as regards practical results, has completetely crowned the patient and laborious investigations of the engineer.

The name of *pozzolana* is given to a volcanic substance found in great abundance in the neighbourhood of Pozzala, and of Rome.

Tarras is a conglomerate, also volcanic, found on the banks of the Rhine, and especially in the environs of Andernach.

To render rich lime hydraulic, it is sufficient to wet it in proper proportions with pozzolana or tarras. What more simple or convenient mode could be imagined? But in many localities the expense of conveyance renders it impossible to use either pozzolana or tarras. Many attempts have been made to prepare substances which possess the same properties. Chaptal thought he had resolved the problem by very much calcinating certain schists or ochreous clay. But even supposing the properties of tarras and pozzolana to be reproduced in this manner, the difficulty was only shifted. The schists experimented on by Chaptal are not common in France; and there is, moreover, in the operation recommended, even if ochreous clay be employed, a circumstance the very high temperature requisite, which opposes an irremediable difficulty.

M. Vicat resolved the questions into its elements. This solution is as follows:—

Artificial pozzolana superior, or at least equal to the best Italian pozzolana may be obtained by a simple manner of using clay of the purest kind. This method consists in *slightly* calcinating the clay, in merely driving off the water of combination, and always keeping the temperature between 600° and 700° centigrade (1·112° to 1·292° Fahr).

The mind rests with satisfaction on the solutions of problems of practical art when they possess this admirable simplicity. On the other hand, one is astonished to see an operation so easy that the workmen call it a *tour de main*, enrich a kingdom, or rather the whole world with a substance eminently useful, and which appeared as if it must inevitably remain the privileged property of a corner of the earth once the seat of volcanic eruptions.

We should fail of our duty if, after having cited the discoveries of M. Vicat in the difficult subject of pozzolanas, we omitted to mention that M. le General Treussart, whose premature loss the whole army deplores, has left a work on this subject filled with useful observations and valuable remarks.

The publications of M. Vicat have long since satisfied all the necessities of art, for the execution of works in fresh water, in canals, rivers, and streams. The sea water gave rise to grave difficulties which no one had anticipated. M. Vicat has the double merit of having pointed out the evil and indicated the remedy.

According to new and quite recent researches of M. Vicat, sea water has some tendency to decompose cements of every kind. It attacks indiscriminately those which contain rich limes or hydraulic limes, natural or artificial pozzolanas. This tendency results from the presence in the water of certain acids which have a great affinity for lime. M. Vicat has found the means of resisting this prejudicial effect and removing it. He is at this time preparing to point out the limes, pozzolanas, and cements which, prepared according to the old methods, will resist the destructive action of the sea; and with respect to others, to shew the modifications to which they must be subjected, to acquire the same power of resistance. It will be apprehended that in so nice a question M. Vicat will be in no haste to announce his discoveries. We may, however, state that the public will in a short time be put in possession of them. It is just to state that they already tend to the rejection of a certain kind of pozzolana proposed for the port of Algiers, and the employment of which has led to such disastrous consequences. The reserve wisely maintained by M. Vicat gives him the opportunity of supporting his system by decisive experiment: the *artificial* pozzolanas employed with so much success at Calais by M. Néhou, Engineer in Chief, are found to satisfy *fortuitously* the conditions, laid down by M. Vicat in his new labours, of preservation against the sea.

Statistics of Hydraulic Limes.

The materials for building recommended by M. Vicat did not meet with the usual fate of new things. The proofs of superiority were palpable, and the old system at once acknowledged itself vanquished. Scarcely had a few months elapsed after the publication of the memoir of the Engineer of the Souillac bridge before the artificial hydraulic lime was brought into use at Paris for quays, at the landings of the bridge of Jena, for the construction of four large *abattoirs*, and for the works on the Canal St. Martin.

Since then the artificial hydraulic lime has been less used; for it is now usually substituted for the natural lime of which the price is lower, and which possesses the same qualities. But we hasten to repeat the remark that it is principally owing to M. Vicat, that constructors daily avail themselves of new wealth in every part of the kingdom.

Our engineer had too much penetration to avoid the conjecture that if, according to his discovery, lime became hydraulic by the simple addition of clay, there must be innumerable formations of argillaceous lime-stones throughout the kingdom capable of affording hydraulic lime by roasting. The idea having taken possession of M. Vicat, he has for twelve years explored almost every one of our Departements. His publications under the modest title *Statistics of Hydraulic Limes*, have revealed this invaluable wealth in numberless localities where its existence was not even suspected. The Departements where natural hydraulic lime is found in the greatest abundance are Lot, Lot-et-Garonne, Tarn, Dordogne, Garel, Ardeche, Drôme, Gers, Charente, Hérault, Cher, Allier, Nièvre, Yonne, Côte-d'Or, Ain, Isere, Jura, Doubs, Haut-Rhin, &c. Of twenty-four Departements already explored, there are no more than six or seven, of primitive earths, where hydraulic lime is entirely wanting.

We proceed to relate two facts which exhibit in a striking manner what was the state of the knowledge of practical men respecting the wealth of our country in hydraulic limes when M. Vicat commenced his examinations for it.

When he visited Marseilles, a new basin was being dug. The contractors were at great expense to get rid of an immense quantity of calcareous refuse. On examination M. Vicat found that this matter would furnish sufficient hydraulic lime for the construction of the whole basin.

The following is a still more remarkable fact, especially when estimated by its consequences.—

At the time of constructing the canals of Bretagne there was great difficulty in procuring hydraulic lime. M. Vicat undertook the mission of visiting the localities, and almost immediately discovered in the quarries of Ponpean, near Rennes, between the beds of rich lime which had been worked from time immemorial, a bed of greenish marl known by the name *brule-mort-vert*, which the lime-makers rejected. This rejected bed, after the examination of M. Vicat supplied not only all the works of the Vilaine, and the canal of Isle-et-Rance, but has become the sole resource of that part of the kingdom for all hydraulic works.

Economical Considerations.

The price of lime almost always forms a considerable item in the cost of masonry. Limes have very different properties which determine the duration of works and the *mode* of executing them. In countries where lime is abundant and of good quality, the buildings last for ages without having required great expenses for their erection. In such districts habitations, even for the poorest classes, may be built with strict regard to healthfulness and preservation from accidents by fire, by the violence of storms, and the destructive effects of inundations and great rains. It is on account of such useful applications as these that the labours of engineers and chemists deserve the attention of the public authorities and the legislature. Let us consider for a moment this phase of the question: let us seek to value the number of the services which, in this respect M. Vicat has rendered to his country.

It was at Paris that the discoveries of M. Vicat first received a powerful impulse from the influence of M. Bruyere, it is at Paris that we find a valuation of the economy effected by these discoveries.

Before 1818 the hydraulic works of the capital were almost all executed in plaster or with rich lime. Thence arose the annual expense of numerous and costly repairs. From 1818, the date of M. Vicat's first publication, recourse was had to hydraulic lime. It is hydraulic lime which gives to new buildings an almost infinite durability.

The same solidity might have been obtained with the lime of Senonches; but the lime of Senonches conveyed to Paris costs 80 to 90 francs the cubic metre, while the lime from the quarries from which plaster is obtained, that lime which, before the researches of M. Vicat, was rejected as refuse, costs about 40 francs. This difference of cost reckoned for 37,000 cubic metres of lime, the quantity used in Paris from 1818 to 1841 in the construction of sewers, reservoirs, canals, &c. gives a total saving of more than 1,500,000 francs.*

One of the members of your Commission superintended part of the works of the fortifications round Paris. He has laid before his colleagues detailed tables, from which it is concluded satisfactorily that at Belleville alone during the years 1840-1-2-3-4 a saving of more than half a million [of francs] has been the consequence of using certain lime which was found on the spot, but which would have been considered of no value before the learned publications of M. Vicat.

We now proceed to offer some tables, in which the saving resulting from the labours of the celebrated engineer appear on the grandest scale.

Sluices and Barrages constructed in France in accordance with the laws of Aug. 5, 1821, and of Aug. 14, 1822.

NAMES OF CANALS.	Number of Sluices.	Number of Barrages.
Rhone and Rhine	162	
Somme	24	
Ardennes	49	
Isle	39	39
Aire and Bassée		
Bourgogne	191	
Nantes and Brest	234	
Isle-et-Rance	28	
Blavet	28	28
Arles and Bone	4	
Nivernais	114	
Berry	115	
Branch to the Loire	45	
Tarn	9	9
Oise	7	7
In accordance with the laws of July 3, 1838, and July 8, 1840.		
Marne and Rhine	180	
Branch to the Garonne	50	
Improvements of River Navigation.		
Branch to the Marne	14	
Charente	10	
Dordogne	9	
Tarn	6	6
Lot	80	47
Totals	1348	186

* About 60,000*l.* English. The metre is rather more than 3 feet 3 inches.—Ed.

LARGE BRIDGES OF HEWN STONE, &c.

To establish a comparison sufficiently exact between the cost of bridges erected on caissons and piles, and of those which, at the present day, are erected on a foundation in concrete, it will be necessary to take some unit of comparison which is independent of the number of arches and their size. We will choose the area of the surface between the parapets for our purpose.

Proceeding thus, it is found for bridges, where it has been possible to substitute the modern method for the ancient that the square metre costs, on the average, 1,312 francs.*

Now, for bridges erected under altogether similar circumstances, but on foundations in concrete, the square metre has cost, on the average 625 francs. The proportion of the expense of the old system to that of the new, is as 100 to 47. According to this calculation, if a bridge erected on foundations like those of Jena or of Sevres cost, on the average, 2,600,000 francs [104,000*l.*] a similar bridge built in the modern plan would not cost more than 1,222,000 fr. [48,880*l.*] consequently the saving would be 1,378,000 francs. Since 1818 there have been 19 great bridges built on foundations in concrete, which, therefore, may be reckoned a saving of 26,182,000 francs [1,047,280*l*].

Of bridges of the average size having a span of 15 or 16 metres for each arch the number is about 30. For each, reckoning in proportion there would be a saving of 235,000 francs, or for the 30 the saving would be 7,050,000 francs [282,000*l.*].

As for bridges of a single arch of 15 to 20 metres span, there have been constructed more than a thousand during the interval of five and twenty years on royal highways and departement-roads. In each of these the average saving by the substitution for coffer dams of hewn stone with concrete, in the foundations has been 25,000 francs, or for the whole 25,000,000 [1,000,000*l.*].

Suspension Bridges.

Prior to July, 1843, there were authorised to be constructed 327 suspension bridges of one, two, three, or four spans. If we calculate each to have a span of 100 metres [325 feet English], each costing 100,000 francs [4,000*l.*], deducting from this sum 30,000 francs [1,200*l.*], the cost of the platform and means of suspension, there remain 70,000 fr. for the foundations and masonry. Experience having showed that for bridges, as for locks, the expense has been reduced more than one half, there would be grounds for reckoning here a reduction still more considerable; still, we will estimate it at one half, and then the saving will be 22,890,000 fr.

Recapitulation of the Economy effected.

	francs.	
Weirs	67,850,000	
Barrages or sluice gates	18,600,000	
Locks, &c.	20,000,000	
Large bridges	26,182,000	
Common bridge	7,050,000	
Single-span bridges	25,000,000	
Suspension bridges	22,890,000	
	182,072,000	[£7,282,880]

Other constructions in which economy has been effected but without sufficient documents to shew the actual amount are,

1. Wooden or iron bridges, on foundations of masonry.
2. Bridge of a single arch, of from 6 to 10 metres span.
3. Marine quays, dikes, basins, &c.
4. Foundation of public and private buildings in towns.
5. Military Works.

It is important to remark, that we have not taken into account the question of time. Now, in these matters, time is money, and becomes, financially speaking, a consideration of the highest importance. The new system of foundations allows the execution of works to be done in one or two years that formerly took five or six. There is therefore in this respect also a considerable saving.

One conclusion springs out of all the preceding evidence—it is that supposing the constructive arts such as they were before 1818, the period of the discoveries of M. Vicat, the greater part of the important works in course of execution would have stopped by the considerations of time and expense.

If we did not estimate, how much the remuneration demanded will acquire value from the imposing manner in which it is granted, we should have omitted all these sums and the accompanying remarks. In a purely financial point of view, what are 6,000 francs pension beside the colossal economies for which the country is indebted to the labours of M. Vicat?

The Works of M. Vicat compared with those of the Ancients

Certain of the learned profess an admiration, absolute, passionate, for the monuments of antiquity. According to them, the Greeks and Romans had discovered everything in the constructive arts. The solidity of edifices yet remaining show that the moderns are the real disciples. M. Vicat has simply *re-discovered* the methods practised in Egypt, at Athens, at Rome, of which the remembrance was lost in the times of barbarism.

Although we do not perceive any injury that these reflections will do

* About 4*l.* 0s. 6. per square foot.

to the labors of M. Vicat—although the discovery of lost truth seems to us altogether similar to the discovery of a new truth—your Commission has devoted itself to a minute examination of the pretended superiority of the ancients over the moderns in the art of building. We have examined, moreover, whether this superiority can be maintained on reference to the progress due to the discoveries of our illustrious engineer.

"Some of the Roman mortars have lasted eighteen centuries. A great number of modern buildings are in a deplorable condition!"

This comparison is essentially erroneous. To give it any value we must draw a parallel between none but the greatest monuments of the two epochs. The results will then be very different to those on which the learned support their position.

The ramparts of the Bastille were of extreme solidity even in the centre of the masonry. It was necessary to use gunpowder to destroy them. Gunpowder was also found necessary a few years ago to destroy at Agen the ruins of a bridge built about the year 1200. M. Vicat himself ascertained that the mortar of the bridge of Valentré, built at Cahors in 1400, surpassed in hardness that of the ancient theatre, of which the ruins are seen in that town.

Ancient architects, like modern, built according to the nature of the materials at their disposal, and also according to finâncial exigencies, either edifices which were indestructible, or with the same exterior forms, temples, palaces, and houses, without solidity. The constructions of the latter class rapidly disappeared. The others alone have resisted the ravages of time and the violence of the seasons. The blind admirers of bygone ages, have they forgotten the words of Pliny, "The cause from which at Rome so many buildings fall is the bad quality of the cement."?

If, as it is pretended, the Romans knew certain methods of preparing good mortar, we ought to find this substance in all their public monuments with qualities almost identical. Now this is not even the case in comparing different parts of the same edifice. The Commission have remarked in many publications of M. Vicat's experiments which throw great light on this subject; those, for instance, made with mortar taken from different points of the bridge of Gard; these experiments give resistances varying in the proportion of *one to three*.

Those who devote themselves to these comparisons should remember that time acts unceasingly in foundations on the hardness of mortar. The mode of action by which this *conglomerate* hardens—acquires adhesiveness—is still a matter of controversy among the learned. But no one can deny that there are circumstances under which it is impossible for this mysterious action to continue for a long series of ages.

It would seem forgotten, that in considering the knowledge of cements in the art of building, we are not reduced to simple conjectures. Vitruvius, contemporary and architect of Augustus, has left a detailed account of the precepts in use among the builders of Greece and Rome. These precepts are far from justifying our unreserved admiration of the ancients.

The ancients were not in possession of any exact notion concerning the chemical modification that calcareous stone undergoes in the kiln, a modification by which its friability is so much increased. Neither did they know anything of the kind of action which restores to the disintegrated molecules of this stone converted into lime, the adhesion and hardness of which they had been deprived by heat. The efforts of Vitruvius to give a plausible explanation were ineffectual. The same was the case until the chemical discoveries of Black respecting carbonic acid, with the attempts of the most illustrious successors of Vitruvius, Scamozzy, Philibert Delorme, Perrault, &c.

One single word will disabuse all those who persuade themselves that the theoretic errors of these great architects are of no consequence. Take the instance of Philibert Delorme: to arrive at a maximum of solidity in edifices, he thought it necessary that the lime should be taken from the same bed of limestone as the materials of the masonry. This direction, if it had been followed out, would have involved an enormous increase of expense.

Builders who regulated the choice of their lime by the colour of the rock from which it is obtained; who were not acquainted with any natural hydraulic lime: who were lavish in mixing with their lime broken pottery and brick rubbish, cannot, without great injustice, be compared with modern constructors. Putting aside the excellent observations on the properties of *natural pozzolanas*, on the possibility of using this material to make enormous artificial blocks to be sunk in the sea, we find that the Romans have taught us nothing essential in the art of building.

For the rest, every attempt to exalt the merit of the ancient in the constructive arts only redounds to the merit of M. Vicat. The best mortar extracted from Roman monuments has, after two thousand years of antiquity, a hardness precisely equal to that which M. Vicat obtained with good limes in the short period of a year or eighteen months. In applying the comparison to average resistances, the advantage greatly preponderates for the modern mortar.

Opinions of Chemists and Builders on the Labours of M. Vicat.

The importance of M. Vicat's discoveries is palpable. For about a quarter of a century all builders have taken advantage of them: now, in such matter, it must be readily understood that it must rest with the actual practitioner to pronounce a definitive judgment. Nevertheless, not to neglect any kind of information, the Commission have thought it right to gather the opinions of chemists and engineers, who are occupied, with the greatest success, in the application of science to the arts. In this examination we have met with the most flattering recognitions of the labours of the celebrated engineer; no one appears to have contested their novelty.

Is the first memoir of M. Vicat on the production of artificial hydraulic lime presented to the Academy of Sciences? That learned body decide on the motion of MM. de Prony, Girard, and Gay-Lussac, that the memoir shall appear in the celebrated collection entitled *Receuil des Savants étrangers*. To this mark of approbation, the greatest that academic commissions ever give, was soon added a proof of esteem sought for throughout the world; the Academy named M. Vicat one of its correspondents.

The Council of Bridges and Highways, called upon at the commencement of 1818, to declare its opinion on the artificial formation of hydraulic lime, declare, by their organ, the accurate and skilful M. Bruyere, "that the advantages of the new method were innumerable, that they dispensed with the costly employment of real pozzolanas, and that of stones of large dimensions, lavishly used in modern buildings, in spite of all the examples to the contrary afforded by the Romans and Goths." "We may predict," adds the sagacious Inspector-General, "that some years hence, no other mortar will be allowed in public buildings. When M. Vicat made known the first part of his statistical labours on the hydraulic limes of France, the Academy decreed to him one of the medals founded by Montyon.

Let us take the opinion of M. Berthier, the most competent judge of the labours of M. Vicat who could be found in the whole world. "The researches of M. Vicat on limes and mortars ought to be placed in the rank of the best works due to members of the *corps* of bridges and highways. His discovery relative to the manufacture of artificial hydraulic limes is of the highest importance . . . . In making it public, M. Vicat has acted the more nobly, because he might have made a considerable fortune either by selling the lime or by securing a patent of his invention."

M. Dumas, (we will quote only those of the greatest celebrity in science) declares in his *Chimie Appliquée aux Arts*, that the solution of the long debated question of hydraulic limes is due *entirely* to the labours of M. Vicat. In speaking of artificial pozzolanas, the illustrious chemist observes, "It is, however, from labours in the laboratory that M. Vicat has been led to the important discovery with which he has enriched the arts. The state in which he found the question renders the discovery the more remarkable."

We could borrow proofs equally flattering from a host of writers, and especially from two excellent articles by M. Chevreuil, inserted in the *Journal des Savants*. These opinions, notwithstanding the high authorities from whom they emanate, ought not, doubtless, to prevent the commission from making the minute enquiry of which the Chamber has heard the results, but your commission, since they have by their own researches been led to the opinions professed by the Academy of Sciences, and the judgments of Gay-Lussac, of Berthier, of Chevreuil, of Dumas, of Bruyere, desire to avail themselves of a circumstance which proves they have not erred.

Conclusion.

To resume;

M. Vicat was the first to demonstrate that the properties of natural hydraulic limes depend on *clay* distributed throughout their substance, that is, on a particular action which silex united with alumina exercises on lime when these substances are brought by heat to a proper state.

M. Vicat has been the first to make hydraulic lime of all kinds, not only in small quantities in the laboratory, but in large quanties for the foundations of his bridge of Souillac. The piers of this noble bridge rest on a foundation of concrete formed with artificial hydraulic lime. Since the labours of M. Vicat, means have been found of procuring, whenever it is necessary, lime, which readily sets in water.

M. Vicat has liberally given his discovery to the public. It is certain that if he had secured by a patent the privilege of making the artificial hydraulic lime, this engineer would have acquired an immense fortune.

The first discovery of M. Vicat has faded, if the expression may be permitted, beside the important results deduced from it. We have seen this indefatigable engineer traversing France step by step, seeking beds of calcareous marl, clay formations in which were united naturally in proper proportions, the constitutive elements of hydraulic limes; we have followed him during twelve years in this search which has become so successful that there are now known on French ground by the sole labours of M. Vicat 900 quarries capable of furnishing hydraulic limes, while before there were reckoned only eight or ten. M. Vicat has so well appreciated the honour of having discovered and placed in the hands of constructors, such wealth hidden in the bowels of the earth, or been rejected at its surface, that in order to complete this work he has recommended the advancement to which his standing and merit give him claims uncontested and incontestible.*

The works of M. Vicat on *pozzolanas* have been equally decisive. They have proved that the parent clays afford artificial pozzolanas superior, or at least equal to the Italian; and as nature has distributed clay with a kind of profusion on the surface of the globe, nothing prevents us at the present day from easily obtaining excellent pozzolana in every region.

France, which before the time of M. Vicat, was tributary to England for Roman cement, could now supply the wants of the whole of Europe.

The general system of foundations, by means of concrete, dates from the

* M. Vicat, appointed divisionary inspector under M. Dufaure, has requested to remain with his rank of engineer in chief to continue the investigation which he has so felicitously commenced.

discoveries which we have analysed, and particularly from the admirable works of the bridge of Souillac. Engineers, to their honour, never refuse to assign a large share to M. Vicat of the success which they obtain, even when circumstances permit them to have recourse exclusively to natural hydraulic lime, and natural pozzolanas. Thus, for example, on the occasion of the entirely successful completion of the new basin for repairing vessels at Toulon, founded 42 feet above the level of the sea, the able director of these works, M. Noel, wrote on the 24th of April last to the Under Secretary to the Department of Public Works; "At a time when the law respecting M. Vicat is about to be discussed, it will not be superfluous to bring to your knowledge a fact which gives a new importance to the labours of the illustrious engineer who has done so much for the advancement of our art."

Thanks to the laborious and patient researches of M. Vicat, works once deemed *impossible*, are executed at the present day safely in every part of the kingdom, and without requiring enormous expenses.

We will not repeat the numerical computations already given respecting the economy effected in public works by M. Vicat's invention. Those computations should be retained in every mind. It would, in fact, be difficult to cite a discovery which, in the short interval of 26 years, has produced such colossal and useful results.

The Commission are unanimously of opinion, that in voting, without some modification, the law which has been proposed by the Minister of Public Works the justice rendered to M. Vicat would not be complete. They would desire that the pension of 6,000 francs should be accorded more explicitly under the title of a *National Recompense*. This is the only change of which the Government proposition appears to us susceptible. We trust that the Chancellor, adopting our opinions respecting the services rendered to the country by M. Vicat, will assent to the amendment which we have the honour of suggesting, and which has already received the sanction of the Minister of Public Works.

ATMOSPHERIC TRACTION.

SIR—Since the appearance of Mr. Haydon's paper in your November Part, I have been inclined to pay some attention to the atmospheric system. The favourable results actually obtained after so few attempts led me to expect some error in the numerical example appended to the forementioned paper, especially when the length of the formula and the difficulty of substitution were taken into account. I made several attempts with the formula as it now stands, but in every case arrived at different results, and each of them at variance with that deduced from the work done each stroke. One source of error seems to have arisen from taking $R = 99$, instead of its exact value $\frac{1053909}{1067374}$ for if $R^n = \frac{1}{3}$ we get $n = 111$ or 87, nearly according as the former or latter is used. I was surprised at the difference in the results, but it teaches us how careful we ought to be to ensure *approximations in our results*. In my application to the example at Dalkey, I shall suppose the whole length of the connecting pipe to be used for propelling the train, as local circumstances compelled them in that instance, to place the engine at an inconvenient and extravagant distance from the main tube.

Let w_n denote the work done during the nth stroke of the air pump.

W_n denote the work done at the end of the nth stroke.

W'_n denote the work done during the motion of the train, their having been n strokes of the air pump before the train started.

W, the useful effect communicated to the tube piston.

Then it is found by Mr. Haydon, that

$$w_n = 15\,a\,k\,R^{n-1}\left\{1 - \overline{n-1}\log_e R + \frac{S-A}{A}\log_e\frac{S-A}{S}\right\}$$

$$W_n = 15\,a\,k\left\{\frac{1-R^n}{1-R}\left(1 + \frac{S-A}{A}\log_e R\right)\right.$$

$$\left. - \left(R\,\frac{1-R^{n-1}}{(1-R)^2} - \frac{\overline{n-1}\,R^n}{1-R}\right)\log_e R\right\}$$

$$\text{Where } R = \frac{B+C}{A+B+C} \text{ and } A+B+C = S$$

$$\therefore (1-R) = 1 - \frac{B+C}{A+B+C} = \frac{A}{S}, \text{ or } \frac{S-A}{S} = R,$$

$$\therefore w_n = 15\,a\,k\,R^{n-1}\left\{1 + \left(\frac{S}{A} - n\right)\log_e R\right\} \qquad \text{(A)}$$

$$W_n = \frac{15\,a\,k}{1-R}\left\{1 - R_n + R_n\log_e R^n\right\} \qquad \text{(B)}$$

after the proper substitutions have been made.

The correctness of the simplification may be tested in the following manner: $W_n - W_n - 1 =$ work done at the nth stroke—that done at the end of the $\overline{n-1}$th.

$$= \frac{15\,a\,k}{1-R}\left\{1 - R^n + R^n n\log_e R - (1 - R^{n-1} + \overline{n-1}\,R^{n-1}\log_e R)\right\}$$

$$= \frac{15\,a\,k}{1-R}\left\{R^{n-1} - R^n + \left(-n\,(R^{n-1} - R^n) + R^{n-1}\right)\log_e R\right\}$$

$$= 15\,a\,k\,R^{n-1}\left\{1 + \left(\frac{1}{1-R} - n\right)\log_e R\right\}$$

$$= 15\,a\,k\,R^{n-1}\left\{1 + \left(\frac{S}{A} - n\right)\log_e R\right\} = W_n = \text{work done during the}$$

nth stroke. Let n have such a value that $R_n = \frac{1}{3}\,m$ then $n = 87$ nearly.

$$W_{87} = \frac{15\,a\,k}{1-R}\left\{1 - \tfrac{1}{3} - \tfrac{1}{3}\log_e 3\right\}$$

$$= \frac{5\,a\,k}{1-R}\left\{2 - (1{\cdot}098612)\right\} = 5\,a\,k\,\frac{S}{A}({\cdot}90138771)$$

$= 720\ S \times 90138771$ lb. raised one foot.

Where $S =$ vol. of the tube and air-pump cylinder expressed in feet.

$W_{87} = 720 \times 10673{\cdot}74 \times {\cdot}90131771 = 6{,}927{,}242.$

$W'_{87} = 5 \times 176{\cdot}7 \times 8588 = 8{,}335{,}720.$

$W = 10 \times 176{\cdot}7 \times 8588 = 15{,}174{,}926.$

$W_{87} + W'_{87} = 15{,}274{,}926 =$ work done.

$W = 15{,}174{,}996 =$ useful effect of work done.

Subtracting, $87{,}972 =$ loss.

Hence the loss is about $\frac{1}{170}$ of the power given out by the engine.

Let $B + C = V =$ vol. of tube to be exhausted; $v =$ vol. of air-pump cylinder; $S = V + v$.

$$W_n = \frac{15\,a\,k}{1-R}\left\{1 - R^n + R^n\log_e R^n\right\}$$

$$= 15\,a\,k\,\frac{(V+v)}{v}\left\{1 - R^n + R^n\log_e R^n\right\}$$

$$= 2160\,(V+v)\left\{1 - R^n + R^n\log_e R\right\}$$

Where V and v are expressed in cubical feet.

$$W'_n = 2160\,R^n\,V\log_e\frac{1}{R^n} = -2160\,R^n\,V\log_e R^n.$$

$$W = 2160\,V\,(1 - R^n)$$

$$W_n + W'_n = 2160\,(1 - R^n + 2160\,v\left\{1 - R^n + R^n\log_e R^n\right\}$$

$$\therefore \text{Loss} = 2160 \times v\left\{1 - R^n + R^n\log_e R^n\right\}$$

For the loss in the Dalkey line we have $= 2160 \times 134{\cdot}65 \times \frac{1}{3}\,({\cdot}90138771) = 720 \times 134{\cdot}65 \times {\cdot}90138771 = 87{,}387$ lb. raised one foot high.

This agrees very nearly with the former result, and therefore we may suppose that the necessary loss is correctly determined.

This we see varies as the volume of the air-pump. If W_n be a maximum

$$\frac{d\,W_n}{d\,n} = 0$$

$$0 = R^n - 1\log_e R\,\left(1 + \left(\frac{S}{A} - n\right)\log_e R\right) - R^{n-1}\log_e R, \text{ or } 0 = \frac{S}{A} - n,$$

$$n = \frac{S}{A} = 79 \text{ nearly.}$$

$R^{79} = \frac{11}{30}$ nearly, which agrees with Mr. Stephenson's experiments.

It may be observed that the above formulæ are true, for positive integral values of n. By examining the diagrams which accompany the Report to the Directors of the Chester and Holyhead Railway, it will be found that the pressure of the air in the pump became equal to the pressure of the atmosphere sooner than we should have expected from theory. This would no doubt be caused in some measure by the heat developed during compression, but before the stroke commenced, the pressure in the pump cylinders generally exceeded that in the branch pipe—so that probably more air rushed into the pump each time than was sufficient to restore the equilibrium with the main tube and its retreat being cut off by the valve, it was expelled by the piston.

I remain,
Your obedient servant,
F. BASHFORTH.

St. John's College, Cambridge, Jan. 15, 1846.

[It may be as well to inform the reader who is not acquainted with mathematics, that the object of Mr. Bashforth is not to controvert the principles of Mr. Haydon's paper, but to effect simplifications by which the arithmetical computations are greatly facilitated. We are, we believe, indebted to these gentlemen for the only accurate mathematical investigations of a very important subject, hitherto published.]—ED.

REVIEWS.

A Treatise on the Steam Engine. By the Artizan Club. Part XVIII. Dec. 1, 1845: Longman, 4to. pp. 16.

This work which has several times been the subject of our reviews is now drawing to a close. Of the twenty-four monthly parts in which it is to be completed, three-fourths are now published. It cannot be denied that a vast mass of information is collected in this work, though some portions might have been omitted without harm. Of the mathematical investigations, parts are of a very doubtful description, and there is not much in the theoretical portion of the work which possesses originality. With respect to the practical views, however, the cause is very different. The writers have a way of looking right at practical questions which is exactly suited to the nature of the subjects; so that even when we dispute their views we are compelled to confess that they are fairly set before us.

The present number is illustrated by a large plate of details of the West India Mail Packets Clyde, Tweed, Tay, and Teviot, exhibiting in a very clear manner the forms of the cylinder and slides, the metallic packing, &c. The most interesting subject treated of in the letter press is a comparison of the merits of the principal forms of *direct action engines* which are divided, into five classes. 1. The Gorgon; 2. the double cylinder; 3. the steeple; 4. the double cross-head; 5. the oscillating. We will give part of the observations made on each class.

1. *The Gorgon Engines* (those which have the connecting rod between the piston rod and the crank). "The objections to the Gorgon plan of engine are numerous and weighty. In the first place, only a very short stroke is attainable by this plan of engine; and although we are not of the number of those who subscribe to the doctrine, that expansion can only be productive of its proper efficacy in a long cylinder, yet we believe that an engine of a moderate stroke will work more steadily and smoothly than when the stroke is short and the reciprocation rapid. There is, moreover, a great waste of steam at the ends of the cylinder when the stroke is short; and although the amount of this loss cannot be great, yet it is too great to be altogether disregarded. We do not attach the importance attributed by some to the deranging influence of a short connecting-rod upon the slide valve, but we attach a good deal of importance to the increased friction consequent upon the thrust, when the angle the connecting-rod makes is great,—not on account of the power absorbed, but on account of the difficulty of keeping the bearings from heating. To *this* objection it is no answer to say, that the friction of a direct-action engine is as little or less than that of a beam engine; the vice being, that the friction is not fairly distributed, but so concentrated at particular points as to be productive of injury in engines of the common proportions.

"There is, however, a far more serious defect of the Gorgon variety of engine than any we have yet mentioned. It involves the use of a large paddle-wheel by the elevation of the shaft, rendered necessary to afford room for the stroke; and the largeness of the wheel gives too great a velocity to the float boards, by which means a considerable proportion of the engine power is dissipated. There is nothing better known, than that in all cases where there is a great disparity between the speed of the wheel and the speed of the ship, a large amount of the power is wasted in throwing the water back from the wheel, instead of being employed in forcing the vessel forwards; and in the Gorgon plan of engine, as applied to ordinary sea-going steamers, a serious loss from this source must be perpetually going on, or else the engine must be working under its proper speed and power. These objections apply to all short connecting-rod engines, of which the stroke is small and the shaft high; and in our eyes, they carry sufficient weight to justify the condemnation of this species of engine *in toto*."

Several varieties of Gorgon engines are then brought under review—those by Boulton and Watt in the "Centaur," by Miller and Ravenhill in the "Eclair," by Fairbairn and Co. in the "Odin," &c. The first introduction of the Gorgon class is attributed to Messrs. Seaward, and the same defect is alleged against every one of the numerous varieties—that of having the shaft too high. The next classes treated of are

2. *The Steeple Engine*, "which is the invention of Mr. David Napier has the merit of being very compact and effectual, and in the case of river vessels, offers advantages which have led to its extended adoption. The protrusion of a large portion of machinery above the deck is, however, much objected to in the case of sea-going vessels, and Messrs. Tod and Macgregor now give the preference to the double cross head engines in such cases. It is a fault, we conceive, to make the air-pump with the same stroke as the cylinder. Where the air-pump bucket moves with a great velocity, the valves strike so forcibly as to wear themselves out very soon. The injury might, however, be mitigated by the use of the Cornish equilibrium valve, both for the delivery valve and the air-pump bucket."

3. *The Double Cylinder Engines.* "Of this plan of engine we cannot approve, and we think Messrs. Maudslay would act wisely by giving it up in favour of some less precarious arrangement. The Siamese plan involves an increased leakage, increased friction, and increased radiation, while the grand purpose of direct action—saving of room—is only imperfectly fulfilled. Should either of the pistons leak steam, moreover, or either of the stuffing boxes leak air, a twist must be given to the parts of the engine, such as would arise if there were more pressure upon one half of a piston than on the other. Such a strain cannot, in our judgment, fail to be sooner or later injurious. The arrangement also involves the use of a low condenser which the air-pump cannot thoroughly drain, and the pitching of the vessel, by causing the water to run from one end of the condenser to the other, sometimes causes the air-pump to make an ineffectual stroke while at other times the air-pump is choked with water, which it can only with difficulty deliver, and fractures occur in consequence."

A long description is then given of the engine of the Ellen Mac Gregor. A very decided preference is given to the fourth and fifth classes above all the rest, and as the treatment of the question involves points long disputed among engineers, we will at the risk of making a rather long extract, give the decision with some few omissions.

4, *The Double Cross-head Engines.* "The nature of the arrangement in the double cross-head engine will be made manifest by a reference to the engines of Messrs. Bury or Messrs. Fawcett. From the top of the piston-rod a cross-head and side-rods proceed as in side-lever engines; and from the lower ends of these side rods other side-rods ascend to a cross-head, situated above the other cross-head, and which, by means of a short arm, communicates with the crank. By this expedient, the benefit of a long connecting-rod is gained without the disadvantages incidental to the plans already mentioned. There is only one air-pump in Messrs. Bury's engine, but it is double-acting, so that, in effect, it is equal to two. A common objection to this description of pump is, that the air accumulates underneath the piston; but it will be remarked, that a provision is made to counteract this tendency, the bulk of the air-pump piston being made to travel past the port, so as to expel air as well as water. We may here remark, that it appears expedient in this engine to avoid injecting from the bilge into the lower condenser, as coal-dust and other foreign matters might be drawn into the air-pump chamber, which would resist the descent of the piston, and probably occasion fracture.

"In Messrs. Fawcett's engine there are two air-pumps, which are wrought by independent bell-cranks off a crank in the intermediate shaft. The inferior cross-head is made in the form of a cross, from the ends of which two rods proceed to a cross-bar working vertically in guides on each side of the cylinder, the effect of this arrangement is to bring the centres of the rods on each side of the cylinder in the same plane, whereby the twist incidental to an overhanging pin is avoided. Messrs. Fawcett have, we understand, since this design was made, more nearly approximated to Messrs. Bury's arrangement; and we believe their engines are likely to become a type which many will follow and many more approve."

5. *Oscillating Engines.* "The most plausible objection to the oscillating engine that we are aware of is, that the cylinder and stuffing-box will speedily become oval, on account of the pressure necessary to communicate motion to the cylinder. The existence of a tendency of this kind cannot be disputed; but it is so small in amount as to be imperceptible in practice; and although, after a lapse of years, it has been found that oscillating cylinders became slightly oval, yet the amount of ellipticity is, for the most part, actually less than is found to exist in the cylinder of common side-lever engines, after the same amount of wear. This, indeed, if the question be considered attentively, is by no means surprising; for the common parallel motion, if in the least degree out of adjustment, will exercise a most severe pressure upon the cylinder; whereas the maximum pressure that can be exerted on the oscillating plan is only that requisite to overcome the friction of the pivots on which the cylinder oscillates, of which the amount is insignificant. Upon the stuffing-box, indeed, the tendency to wear oval may be more operative, but, to counteract this tendency, it is made of unusual depth, and a very substantial brass bush is fitted into its interior portion. The piston rod, moreover, is made of cast steel; and, with these precautions, oscillating engines are found to work, for a number of years, without inconvenience from the causes mentioned.

"Many nautical men, and some engineers, have objected to oscillating engines on account of the movement of the cylinder, which, they imagine, would become a formidable evil in the case of a vessel rolling heavily at sea. These objectors do not seem to have remarked that the rolling of the cylinder is neither dependent upon, nor proportionate to, the rolling of the ship, but is regulated exclusively by the movement of the piston; and we really do not see why a mass of matter, in the form of a cylinder, should be more formidable or intractable in its movements than a similar quantity of matter in the form of a side lever, or in any other shape whatever.

"It has also been objected against the oscillating engine, that the eduction passages are more tortuous than in common engines, so that the steam gets out of the cylinder less freely. We do not believe such to be the fact, if the comparison be made with the common run of marine engines; and in practice, no diminution of efficacy from this cause is appreciable. The fact is, all the objections that have been raised to the oscillating engine are merely hypothetical; they are anticipations of defects to be found out in large engines on the oscillating plan, and would probably be plausible enough to carry some weight, were it not the fact, that they have been completely controverted by experience. The remark, indeed, is heard sometimes even yet, that the oscillating method may do very well for small engines, but is of doubtful efficacy for large ones. But the definition of large engines has been continually changed, to escape the contradiction experience afforded, and that size is, in every case, decided to be large, which just exceeds the size of the oscillating engine last constructed. It is plain, however, that the grounds of this scepticism are being fast contracted; and, indeed, we think it requires a little controversial intrepidity to set down engines of 62-inch cylinders, which is the size of those of the "Black Eagle," as among the number of small engines. And if engines of this size are found to operate well—and those of the "Black Eagle" have been found to perform most satisfactorily—it really appears to us impossible to suppose that engines of 5 or 10 inches more cylinder would not be found correspondingly effective."

The points here discussed are many of them of that complicated nature, that independent reasoning will not suffice for the decision of them. The ultimate verdict must depend on a much more extended experience than we at present possess. However, notices such as the above, in which engines of each kind are examined together and their defects compared, have the happiest effect in removing prejudices.

Weale's Quarterly papers on Engineering. Part IX, quarto, p. p. 240. 23 engravings. Weale, High Holborn.

The present Part of Mr. Weale's series of magnificently printed and illustrated volumes, is that for Michaelmas 1845, but the publication of it has been unavoidably postponed to January 1846, owing, as it is stated, to "the engagements in Railway matters of two of the gentlemen contributors." There are four papers in the present number; of which the first and third may be considered together, as both are chiefly of a historical nature; the subjects of them being respectively "the Progress of Machinery and Manufactures in Great Britain, from the earliest times to Queen Elizabeth," and "a memoir of the Thames Tunnel. Section II., by Henry Law." The first of these papers gives a historical account of the progress of the arts, year by year, in England; the principal enactments affecting manufactures and inventions, the importation of foreign improvements, &c. Some of the notices are very curious and interesting.—In 1404 we find Henry IV. ordaining "that none henceforth shall use to multiply gold or silver, nor use the craft of *multiplication* under the pain of felony." The paper closes with an account of the disputes between Elizabeth and her Parliament, respecting the royal, fondly-cherished, privilege of granting patents for monopolies.

Mr. Law's paper is also interesting, and will be very acceptable to those who feel the value of tracing the *history* of Engineering. This branch of knowledge is much neglected at the present day; we seem content with ascertaining the actual state of Engineering, and care but little to know how and by whom the advancement of practical science has been effected. The paper on the Thames Tunnel supplies a very important point in the annals of mechanics. It details in distinct and forcible language the wonderful skill and patience by which the difficulties attending that great work were overcome, and deserves to be read with the greatest attention.

The second paper is entitled "*Practical and Experimental Researches in Hydraulics*, by R. H. Peacocke, E. C.;" the object proposed is to suggest formulæ for calculating the discharge of water from pipes, &c. The first investigation which the author makes, tends to show that the curve which water assumes when discharged from a pipe is not a parabola. It may be as well to remark, *in limine*, that the form of the curve in which water actually falls is never taken to be exactly a parabola; because it is natural to conclude that if a projectile *in air* do not describe a parabola neither will falling water. Mr. Peacocke, suggests a formula for calculating the curve of falling water in the following terms;

"The hydraulic curve consists of ordinates of a parabola plus, (sometimes minus) a certain constant quantity which increases arithmetically as the corresponding abscissæ increase." p. 3.

It is not very easy to see how a "certain *constant* quantity" can increase arithmetically; and we find out afterwards that this quantity is no *factor* at all, but something to be simply added to, not multiplied by, the length of the ordinate. We apprehend Mr. Peacocke's meaning to be—that his curve is found by adding to, or substracting from, the ordinates of a parabola, quantities proportional to the corresponding abscissæ. For instance, in his first experiment he substracts from each ordinate the decimal part .07 of each corresponding abscissa, in the second experiment he substracts ·09 of each abscissæ, &c. But one great defect which seems fatal to his formula is, that it leaves quite undetermined *what* proportions of the abscissæ are to be substracted. These decimal parts .07, .09, &c., are wholly empirical, and only suitable for the *particular* cases to which they are respectively applied. He, himself says, of his "factors," as they are termed throughout,

"In Experiment	1.	The factor is	—.07.
"	2.	Ditto	—.09
"	3.	Ditto	—. a minute quantity not ascertained
"	4.	Ditto	+.03
"	5.	Ditto	0

On comparison of these factors, and consideration of them with reference to the lengths and diameters of the tubes, and the amounts of "head"—*it is not observable that the factors follow any definite law;* though it is probable that a greater number of experiments would have proved the existence of a definite law. But the farther prosecution of the subject in that way, though it would have been interesting, was not necessary to my present purpose."

So that we really cannot see in what way we are the wiser for his experiments. In two out of five of them he does not determine any "factor" whatever, and in the remaining three the factors apply only to the particular cases and suggest no general law.

It is important to remark that Mr. Peacocke merely observed the form of the curve near the orifice. His experiments for the determination of the curve do not extend to a fall of four feet below the discharge pipe. Now it is very possible the proposed formulæ may represent a curve, resembling that of falling water near its source, but widely diverging from it at a great distance from the source; for with short lengths of the curve, errors would not be easily detected. It may readily be conceived that by Mr. Peacocke's system of "factors" (determined, it is to be observed, separately for each case,) he may get a formulæ which coincides with the results of his experiments as far as they extend, but *not* much farther;—and we must be excused for adding that it is also possible to conceive the existence of a formula of entirely different shape, and involving altogether different functions, which would represent the form of the curve both near and at a distance from the origin.

The experiments are followed by an examination of formula, proposed by Mr. Smeaton, M. Prony, Dr. Young, Chevalier Dubuat, M. Eytelwein, &c. for the discharge of water. The following conclusions are ultimately made.

"1st. How nearly the experiments are a mean of the two extreme formulæ, namely, those of M. Eytelwein and M. Genieys.

2nd. How nearly the experiments are a mean of the two next formulæ, namely, those of Mr. Smeaton and Chevalier Dubuat.

3rd. How very nearly the experiments are a mean of the two most accurate formulæ, namely, those of M. Prony and Dr. Young.

I think no scientific man will, after satisfying himself that my calculations are correctly made from M. Eytelwein's and M. Genieys' directions, make use of either of these gentlemen's formulæ."

Having some curiosity to know on what data the condemnation of Eytelwein's formulæ, which has considerable reputation, was founded, we turned to Mr. Peacocke's examination of that particular formulæ, and found that he had by his own showing, taken the value of one symbol at one-fourth of that intended by Eytelwein. He says that Dr. Young understands the symbol *d* in the formulæ "to signify the diameter, (of the discharge pipe) while I understand it to mean the hydraulic mean depth, or *one-fourth* of the diameter of the pipe," and then adds in a note that he finds on reference to the original work in German, that Dr. Young is right, but that he himself was misled by the Encyclopædia Britannica.

"I have, since this essay was in type, referred to M. Eytelwein's original work in German; and have found that *d* signifies *the diameter*, consequently the writer in the Encyclopædia Britannica has (unintentionally of course) mis-stated M. Eytelwein's formula."

The paper certainly evinces great labour, but such an error as the above is rather a serious one; and the writer must not be surprised to find that in a subject which has baffled the sagacity of the acutest philosophers, the proposition of new empirical formulæ will be regarded with distrust, unless they be supported by a weight of testimony far exceeding any hitherto collected.

The last paper is a report of the Institute of France, on M. Arnolett's system of Atmospheric Railway. This paper is translated and prepared for publication by Mr. R. Mallet, A B. CE., who prefixes an introduction explaining "the views and objects" which influenced him in publishing the report in English. After assigning various reasons, he brings forward the following in a paragraph by itself.

"My principal inducement, however, has been to make readily available to the English engineer the mathematical notes of M. Lamè, appended to the report of the commission."

Now when we find, as we presently shall, that these "mathematical notes" are not only incorrect, but that there is scarcely one line free from gross errors, we can scarcely be expected to give great credit to Mr. Mallet, for his judgment in selection. It is necessary to state that M. Lamé's investigations exclude the supposition of leakage in the main pipe: the reason, stated in the body of the report, is that "as this defect of the apparatus and the loss of power which it occasions have not yet been sufficiently considered, we shall neglect it in comparing the two systems."

We take the first dozen lines of the "notes" as a sample of their general character. The object is to calculate the power required in the *preliminary exhaustion* of a tube of the length Λ and section S, from a density H to a density η.

"We will assume the tube to have a fixed bottom, taken for the origin of x, and that it is closed towards its other end by a moveable piston, P, beyond which the tube is indefinitely prolonged.

We readily perceive that the power sought is equal to that which will be required to draw out the piston P, placed originally at a distance $x = \frac{\Lambda\eta}{H}$, from the fixed bottom to the distance Λ. H being the density of the air contained in the tube of the length $\frac{\Lambda\eta}{H}$, let p be the elastic force of this air for any length, x; we then have

$$p = \frac{\Lambda\eta}{x} \text{ or } H - p = H - \frac{\Lambda\eta}{x}$$

and the power sought will be given by the definite integral.

$$\int_{\frac{\Lambda\eta}{H}}^{\Lambda} S\left(H = \frac{\Lambda\eta}{x}\right) dx = S\Lambda\left(H = \eta - \eta \log. \frac{H}{\eta}\right). \quad (1)\text{"}$$

In this calculation we first of all observe that the alternating action of the air-pumps, and the influence of the external valves (those through which the air is expelled from the pump) are totally neglected. But the whole amount of error is not perceived till we come to see to what use this formula (1) is applied. The conclusion from it is thus expressed, at p. 14. "Hence we conclude that in the English system, the available power expended, however the engine work, is exactly equal to the work done."

Now the full force of the reasoning amounts to this—the passage quoted above, and commencing "we readily perceive that the power sought is, &c." assumes that the *power expended* may be measured by the *useful effect produced*: having made this assumption, M. Lamé gets a formula from it, which he concludes that *the power expended* is equal to the *useful effect produced*, that is—he assumes a proposition in order to prove the truth of it.

The mathematical reader will have no difficulty in seeing that this logic is as bad an example of reasoning in a circle as can possibly be found. But we want, if possible, to convince the *un*mathematical reader—for it is he who is most likely to be injured by errors so gross as this appearing in a work like the "Quarterly papers." M. Lamè totally overlooks the loss arising from the employment of an elastic agent for communicating power. This simple consideration, as we said last month, will shew that the power expended cannot be mathematically equal to the effect produced—the alternating action of the pump-piston alternately dilates and condenses the air in the pump—dilates it while draining it from the main tube — condenses it while expelling it into the external air. Consequently all the component particles of the air in the pump are first drawn further apart, and secondly are brought closer together, than they are in their natural state. Now to suppose that *no* force is expended in thus continually altering the constituent arrangement of the particles of air is equivalent to asserting that the change takes place spontaneously, that the molecules can of themselves approach and recede from each other—that is, that they have a kind of vitality in them, an inherent power of moving themselves.

It may seem bold to attack opinions sanctioned by such high authority as that of M. Lamé; but philosophy does not recognise the weight of personal testimony. It is the obvious duty of the reviewer to point out errors wherever he finds them, and his duty is only increased in importance where errors seem confirmed by the celebrity of their advocate. The proposition of M. Lamè, to somewhat vary the view of it, may be stated thus:—The requisite exhaustion *might* be produced in the tube by moving a piston within it through a certain distance; and hence the force required is the same whether the effect be produced by this hypothetical arrangement, or by that *really* employed in practice. That is, provided the result be the same, the means of effecting it are matters of indifference! Now this assumption that no more force is lost by the use of air-pumps than by an arrangement more direct, but entirely imaginary, what is it but an assumption of the very question in debate, namely, whether the power, expended by the air-pumps &c., be equal to the useful effect? It is clear that the mechanical means by which the effect is produced cannot be neglected in the calculation, for it would be easy to contrive machines which would effect the requisite exhaustion with a loss of 99 per cent of their power.

It is very true, that the investigation of Mr. Bashforth, in another page of this number, shews that the loss under consideration is but *small*; but the mathematical truth remains independent of the actual amount of the loss. Whether that amount be 1 per cent. or 99 per cent., the fact remains the same, that mathematics founded on the assumption that the effect produced is equal to the power expended must be erroneous.

If any confirmation of this opinion were requisite, the following extract, from the "notes" of M. Lamè, almost immediately following the one made above, is perfectly conclusive:—

"Thus the power expended to form the vacuum in the tube before the starting of the train is to the whole power as (2 — log. 3) is to 2, or since the hyperbolic logarithm of 3 is = 1.09861 — the time of working of the engine is to the time of transit of the train as 2 is to 1.09861, that is to say, a little more than double, or more exactly, as 9 : 5."

Here it is asserted, that for a working pressure of 10 lb. to the square inch, the preliminary exhaustion will be *always* $\frac{4}{9}$ of the whole power expended. And it is particularly to be observed, that this conclusion is independent of the length of the main tube, or the size of the air pump; whereas, in truth, the power expended in the preliminary exhaustion depends most materially on the relation between the solid content of the pump and that of the tube. Every tyro in pneumatics knows that the density of air in an exhausted receiver depends on a formula in which the number of each stroke appears as a *power* or *index*. For instance, if the capacity of the pump and receiver *together* were to the capacity of the receiver alone as 20 : 19, the density after the first stroke would be expressed by $\frac{19}{20}$; after the second stroke by the square of $\frac{19}{20}$; after the third by the cube of $\frac{19}{20}$; after the fourth by the fourth power of $\frac{19}{20}$...... after the hundredth by the hundredth power of $\frac{19}{20}$. Now these considerations, which are to be found in every elementary book on pneumatics, are totally neglected by M. Lamè, not only in the passage here quoted, but throughout his investigation.

The "mathematical notes" next discuss "M. Arnollet's system," in which magazines of power are obtained by the exhaustion of large air-tight reservoirs. The mathematics are here founded on the same reasoning as before—that is, the alternate action of the pump and the proportion of its size to that of the tube are quite left out of sight. It would be worse than useless to quote conclusions obtained under these unsatisfactory circumstances.

What adds greatly to the regret, excited by finding these calculations in a report by a commission of the Institute of France, is the circumstance that M. Arago's name is attached to the report.

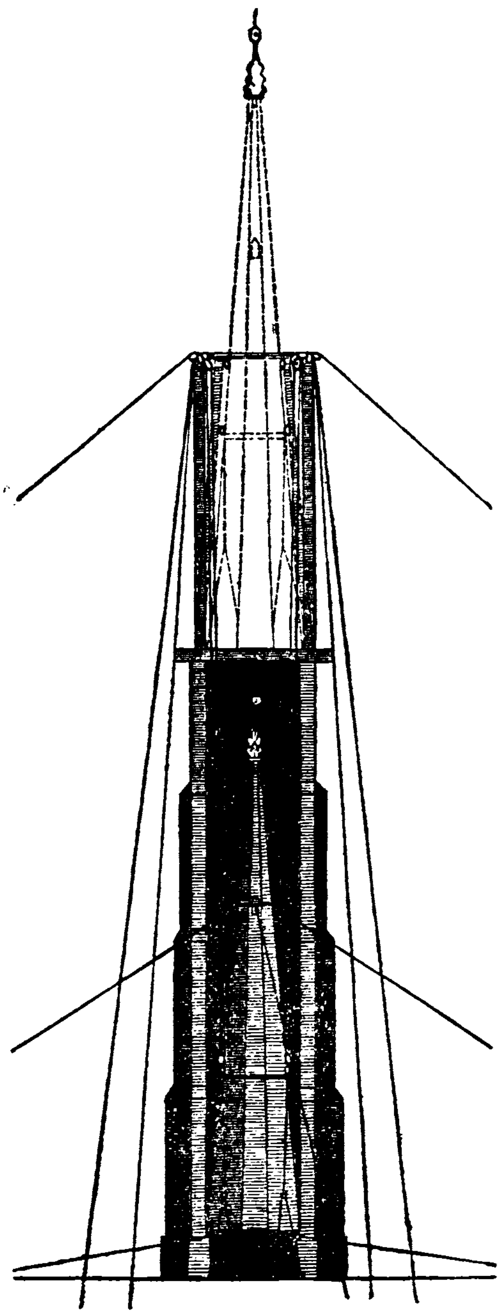
Engineering seems fated to be particularly unfortunate, in being obscured by incorrect mathematics. Were the confused heaps of mathematical symbols which beset the path of the engineering student merely worthless, we would not say one word respecting them. They might safely be consigned to oblivion. But, unfortunately, these errors have the most pernicious effect on those who are least able to discover them. Mathematics of the very worst kind are constantly receiving the highest sanction when applied to engineering. In any other department of science the authors would infallibly meet with condemnation. We can only give general advice to the student who is likely to be affected by these evils, —never to take on trust any mathematical conclusions except those sanctioned by time, and embodied in works of accredited authority: respecting all new investigations, we recommend him to reject them altogether until he feels his physical views sufficiently matured to enable him to investigate and confidently decide for himself.

RAISING THE SPIRE OF A CHURCH.

(From the American *Franklin Journal.*)

"*Account of the Raising of the Spire of the Nativity, in Spring Garden, Philadelphia county.*" By N. Le Brun, Architect.

The Doric tower on which this spire was raised, faces the east, and is 90 feet in height; it is strengthened at the angles by four buttresses, projecting at the base four feet; the projection of these buttresses is diminished at four stages in their height. The interior figure of the tower at the base is a square, but mid-way it assumes the figure of an octagon by gathering over the brickwork at the angles; the whole forming a construction of the most solid character. The octagonal spire, which was finished complete in front of the tower previous to rising, is 80 feet high, including its crowning ornaments; its width at the base is 12 feet 6 inches.



The spire was raised by means of two derricks situated on the north and south wall on the top of the tower, and placed about 18 inches behind the front posts of the spire, or about 3 feet back from the front of the tower, and were 13 feet, 6 inches apart, allowing about 6 inches on each side between them and the spire. Their feet were made convex and fitted into corresponding cavities worked in the oak sleepers which were securely bolted down into the sills of the spire, which sills were themselves secured to the tower by 1½ inch rods 36 feet long, and built in the angles of the tower walls. To avoid all the strain being thrown on the top of the walls at these points, diagonal braces were placed, extending 40 feet down the tower, and as an additional precaution to prevent the derricks from slipping at the heels, they were connected by lashings fastened to iron bolts passed through them,—the heads were connected by two tackle blocks, which were only of use to keep them in their position till the spire was being raised. The guys from each of the derricks, extended in three directions over the neighbouring commons.

The spire was connected with the derricks by four double lashings, (each end of which was fastened to one of the spire posts at the foot,) and two spans; the belt, which connected the spans, was 30 feet high above the base of the spire, (being about 5 feet above the centre of gravity) and passed through the straps of the purchase blocks. The falls from the treble blocks on the derricks to the leading blocks, were in the interior of the tower, and the two capstans used, were placed in the main story of the church, and were each manned by twenty men. Attached to the base of the spire were three guys, and at about 25 feet from the head were four more guys, all secured to guy posts.

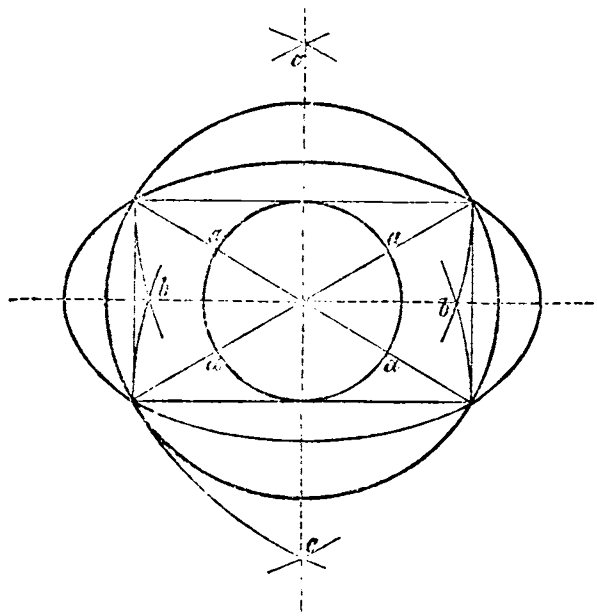
All the arrangements having been made with the greatest care, on the 10th of February, at two o'clock in the afternoon, the raising was commenced, and it was performed with the greatest ease. The spire was kept plumb by the management of the guys attached to it. As the derricks were but 42 feet high, and the belt to which the purchase blocks was fastened was 30 feet from the base, (at which height the distance from each derrick head to the spire would be about 3 feet,) there would be but 6 feet between the blocks when the spire would be raised;—they would thus necessarily have lain almost horizontal, and caused a great strain on them; to avoid this strain, as the raising was progressing, the north and south derrick guys were slackened to make the purchase blocks work more perpendicularly.

When the spire had been raised to its proper height in front of the tower, the two west derrick guys were worked by two crabs to draw over the derricks and swing the spire to its destined position. It had been deemed most prudent to work them in that manner, as in the hauling in of the back guys in the usual manner, an oscillatory motion might have been communicated to the spire, which would have rendered it difficult to manage at this most critical moment. The raising lasted an hour and thirty minutes, and thirty minutes were required to secure it firmly to the sills on the tower by the iron straps;—thus the whole operation occupied two hours.

METHOD TO PROJECT CIRCLES ISOMETRICALLY.

By Thomas Prosser, C.E., New York.

Fig. 1. Draw the two Isometrical diameters; (*i. e.* the two exi-conjugate diameters of the ellipse which is to represent the circle,) unite their vertises so as to form a rectangle with its diagonals; circumscribe the whole with a circle passing through each angle of the parellelogram, the sides of which will thus form chords to its segments; with the chord of half the arc of a lesser segment as radius, describe another concentric circle cutting the diagonals of the rectangle, at *a, a, a, a*.



From each angle of the rectangle as centres, and with its largest side as radius, describe arcs cutting each other within the rectangle as at *b, b.*

From the same centres, and with the diagonal of the rectangle as radius, describe arcs on the opposite side of the figure, as at *c*, *c*.

From each of the points *a*, *a*, *a*, *a*, as centres, describe arcs passing through the vertises of the isometrical diameters which are on the same side of the conjugate axis, but on the opposite side of the transverse one. From the points *b*, *b*, and *c*, *c*, as centres, describe arcs in continuation.

REPORT FROM THE INSTITUTE OF THE FINE ARTS ON PUBLIC COMPETITIONS.

"Gentlemen—Competitions in art are now so frequent and so fully responded to that, without sound principles in their management, they must necessarily be very injurious to the artists, however advantageous they may appear to the public; for instance, in the case before us, if 1,000*l*. has to be competed for, and fifty artists enter the lists and spend 1,800*l*. of money and an amount of time equal to twenty-nine years of human life, as this inquiry will demonstrate, they evidently lose 1.800*l*. and the whole of that time, unless there is compensation by reputation, by acquired knowledge which may be turned to account, or in the sale of the competition pictures. If wholesome condition of public taste, good sense in the arrangements, and strict justice in the awards at competitions, would, in some measure, afford this compensation, but the usual modes adopted in these trials of skill afford none; on the contrary, they are attended with many circumstances that embitter the feelings, aggravate the sufferings, and injure the reputation of enthusiastic competitors. Such a course must ultimately be injurious to the public as well as to the artist. The system has indeed much of the excitement and immoral tendencies of a lottery.

In order to arrive at a better principle, we have inquired into the results of various competitions in different ages, and in several countries; we have endeavoured to trace the amount of competency in the judges and of equity in the mode of arrangement, or of good faith in the superintending authorities. Among the ancient Greeks various plans were adopted, according to the more or less popular political institutions of the community. Where the arts flourished most, public opinion, in whatever form expressed, was the basis of public patronage. In some cases the community, considering the competing artists most interested in a fair decision, actually left that decision to them; in others the opinion of the people was paramount; but even then suggestions from the artists were attended to with deference and respect, and not disregarded or condemned as is too often done among us. When Phidias and Alcamenes competed for a statue to be placed on a column or other elevated situation, at first sight all opinions were in favour of Alcamenes, but Phidias demanded that both figures should be placed at the intended elevation, previous to the award being made. This was done, and such was the consideration of perspective effect by the one artist and its neglect by the other, that the people no sooner saw them at their required elevation, than they changed their opinion, and decided in favour of Phidias. In this instance it is clear that the judges, *i. e.* the public, were not fully competent to their task, but it is also obvious that such artists as Alcamenes would have been equally unfit or even worse; for, in all probability, relying on their practice and skill, they would not have taken the trouble to raise the competing statues to the proposed elevation, and in all likelihood they would have been more tenacious of a first opinion than the people were.

In the case of the citizens of Cos choosing a statue of Venus from two by Praxiteles, so far from delegating their judgment to artists, they selected, from a motive of delicacy, that which the technical connoisseurs denounced as inferior. Posterity has decreed that in this, good sense triumphed over conventional excellence.

Much has been said of a mode of deciding some competitions among artists in ancient Greece, in which the competitors were each allowed two votes, under the notion that in the ballot, each would give one vote in favour of his own performance, and the other to the best of his rivals; as though all the candidates, after indulging a selfish conceit, would, as soon as that first impulse was gratified, become perfectly candid; as though the act performed by one hand, and its motive, were unknown to the other? Unless they were strictly honourable and impartial, it is more likely that they would give both votes to their own work, or the second vote to the most unlikely rival; thus might the least talented stand at the head of the poll: we have been informed of occurrences which confirm this opinion. On one occasion at one of our distinguished institutions, a candidate was elected to an important office, for which he was so totally unfit, that the self-degraded electors had to request their own nominee to resign; on another, an individual of considerable reputation, after proposing and making a warm eulogy of a friend's qualifications, was proved, by the unanimity of the votes in favour of himself, to have sacrificed that friend to his own conceit. If candidates are honourable and true, one vote is as good as two; and so it would be if they were all selfish and cunning.

Early in the fourteenth century, a very important competition took place at Florence, between Bruneleschi, Donatello, Ghiberti, and four other eminent sculptors; for under good and honourable regulations, the greatest were not loth to compete. Subjects, to be executed in bronze, for the ornament of the gates of the Baptistery of St. John, were confided to their emulation, each being provided, at the public expense, with every convenience of studio, furnace, and other accommodation, that could ensure success, and a sum for personal expenses. Having done so much for the comfort of the artists during the period of their exertions, a competent tribunal next received the consideration of the Florentines; thirty-four men of taste and talent, some artists and some amateurs, were appointed judges to determine which was entitled to especial admiration, and public employment. Their votes were divided, and no decision obtained from them; but the magnanimous candour of Bruneleschi and Donatello, who had each the same number of votes as Ghiberti, at once settled it in his favour, and proved the tribunal incompetent: those generous rivals saw no room to doubt his superiority in that contest; and posterity has sanctioned their opinion. The incompetency of this tribunal was, however, but negatively bad; it allowed the scales of justice to remain in doubtful suspension, but it did not actually reverse its tendency, and cloud the prospects and fame of a deserving candidate. A similar diffidence, or modest ignorance, was remarkable when Leonardo da Vinci, and Michael Angelo Buonarotti, made their great trial of skill at the Council Chamber; the splendour of the one did not eclipse the majesty of the other, as the success of one man's talent invariably smothers the fame of every other in our modern competitions.

In France, during the period of religious animosity, from the reign of Francis the First to that of Louis the Fourteenth, public competitions were often productive of fine works, as the best portions of the palace of Fontainebleau, and the beautiful square of the Louvre attest. In those instances, native talent, both Catholic and Protestant, in worthy emulation, stands triumphant amidst the performances of foreign rivalry. The same system was resorted to for the east front of the Louvre, and the award of superior merit was in favour of Claude Perrault, the physician and mathematician, but a corrupt court, where the spirit of intellectual freedom had not survived that of anarchy and rebellion, could not rest satisfied with the result of competition and public opinion. Louis the Fourteenth endeavoured to set aside the design of Perrault, and invited Bernini, the fashionable Italian architect and sculptor of the day, to visit his court and design something worthy the magnificence and splendour of that pompous monarch. Princely honours attended on the foreign artist in his progress to the French capital, but Colbert found it advisable to lean towards the popular opinion: the king relented, Bernini retired with the same affected magnificence that accompanied his arrival, and the design of Perrault, the masterpiece of that era, before which even Whitehall sinks in comparison, was completed, at once a monument to French taste and a trophy to public opinion.

Under Napoleon, competition was far from pure. The jury of artists for the Decennal prizes adjudged the great prize for a subject of ancient history to Girodet, for a scene of the Deluge. The emperor was disappointed: he had expected that prize to be given to his first painter, David, for the intercession of the Sabine women between their enraged relatives and their Roman husbands. The judges could not indeed be induced to convict themselves of incompetency in that decision; but, to conciliate the sovereign, in the next trial, they conferred the prize for a modern subject on David's coronation, and not on the plague of Jaffa, by Gros, which they individually preferred. A sad example of artists, eminent for talent and character, rendered dishonest by the interference of a potentate.

At the present time in France, where artists constitute an influential portion of the intellectual aristocracy (the aristocracy of talent and professions); where authority and intrigue are variously apportioned, no one competition is of much importance, for the effect of a partial decision by the court party, is frequently neutralised by an equally unsound award in favour of the injured artist, by some municipality of opposition politics, to whose prejudices an appeal is made, and who have in their gift a provincial commission.

In our own country, competitions are very unsatisfactory, and frequently alike absurd and unjust: in that for the Nelson memorial, the vacillation of the committee in setting aside their first hasty award, and advertising a new contest and exhibition, with their final confirmation of that first very doubtful judgment, compromised the dignity of the committee as much as its taste, and unnecessarily increased by many thousands of pounds the expense (besides trouble) of the artists. That competition was fatal to the confidence of artists in a tribunal of amateurs of rank and fortune, but that of the Royal Exchange with a tribunal of artists was still worse: the jury of three eminent architects, refused any premium to the design which they acknowledged to be the best, under the plea that it could not be built for the sum stipulated; nor was that decree reversed when contractors of reputation offered to undertake it under securities; but they gave the premiums to other candidates, whose designs they declared to be quite impracticable. They were next requested to prepare a design themselves. It is understood, that two of those three judges, after examining and condemning all the designs, actually consented to do so, but the unseemly proceeding was checked by public opinion. The ultimate competition was between two architects of considerable and nearly equal influence among the civic authorities.

The recent competition exhibitions at Westminster Hall, for the decoration of the Parliament Houses, were at first hailed as the beginning of a better system, more intellectual and pure; but up to the present time, the results have led only to disappointment among the great body of the candidates, and growing indifference in the public. Some artists, after being rewarded the first year, had their works treated as unworthy even to be publicly exhibited at the second, whilst others have been appointed for actual employment on one trial, or even without passing through the prescribed ordeal at all. Several who have appeared honourably and with general approbation at all the exhibitions, have been utterly neglected or discarded by the royal commission, although the leading object of its appointment was the encouragement of native talent in the higher walks of art, and the commissioners had pronounced the works of many of those artists "highly creditable to the country."

The whole of the evidence on competitions, tends to prove that in respect of matters of art, a competent tribunal and equal justice have scarcely ever been obtained. In questions of taste, there is indeed so much room for doubt, that prevarication and partiality are less obvious and disgraceful than in simple questions of property, and yet the injury done to the sufferers is far greater where professional reputation as well as fortune is involved. Why should not artists, whose fame and means of existence are at stake, have as good protection from a committee of taste, as persons in trade are sure to find in a court of justice? Why are not committees, like judges and juries, responsible fer their proceedings, either to a higher tribunal or to public opinion? Why are they not, in like manner, obliged to examine and consider both sides of the question? Our juries are selected for their impartiality, and every accident in that respect is rectified, by allowing each contesting party to challenge the jurors: no false delicacy towards jurymen is allowed to weigh against the welfare of the parties before the court and the strict rules of justice. To see that they attend to their prescribed duties, and that the evidence is fairly placed before them, and not to interfere with the verdict, a judge presides who, after a long career of study and experience, is placed above ordinary rivalry and contention, in circumstances that render character, especially for impartiality and judgment, to him, all-important. Should he, forgetful of his high responsibility, lean unduly to one side and misdirect the jury, an appeal lies to a higher Court, where his error or misinterpretation is sure to be severely discussed, and, if a case is made out, the trial is set aside or the verdict is reversed, without the least complacency for his authority and feelings. Thus is the property of the humblest trader protected; thus the life or liberty of the poorest wretch accused of crime, is held paramount to all considerations of rank and station. In questions of property, every possible discussion has long been afforded; witnesses are examined, cross-examined, and re-examined, by contending advocates. The same protection has of late years been granted to persons criminally indicted.—And why should this wholesome respect for mutual rights be denied to men of intellectual pursuits—authors or artists, who embark fame and fortune on the tide of public competition? Why should those to whom they entrust all that is precious in their estimation, think lightly of their responsibility. Something like the system of judge and jury, or an assimilation to the best of our prerogative Courts can alone render competitions among artists fair, honourable, and efficient, and give to the emanations of genius their proper value among us.

In the case immediately before us, it is proposed that a prize of 1,000*l*. be given to the artist who, in general competition, shall produce the bes painting 12 or 15 feet one way, and 10 or 12 the other; the subject is defined, and, in several points, the precise mode of treating it. With so great a temptation, it is reasonable to suppose that many will overlook the expense, trouble, disappointment, and serious inconveniences that await all but the one fortunate candidate; it is reasonable to suppose that fifty artists may risk comfort and reputation in the attempt. We feel assured that the gentlemen who propose this competition, besides the desire to obtain as fine a picture as possible, are anxious to make it worth while to men of talent and character to vie with each other in honourable emulation. They would evince generous delicacy towards the less successful artists who gave proof of high talent in the contest; for their object is not to encourage speculators to make a heedless dash at the 1,000*l*., nor can they wish for a gaudy meritricious picture, but one wherein the subject is fully considered, the character of each figure is faithfully studied and pathetically delineated;—where the action of all is in due relation one with the other, and the whole is combined into a rational and picturesque composition. Such are the essentials of high art; they are best attended to in the simplest and least expensive materials, such as involve a larger outlay of mind in proportion to that of money. Thus may the best results be obtained with as little injury as possible to the candidates, as all virtuous and religious men must wish to do.

We now proceed to state the artist's case in two ways:—first, as it will stand if the advertised regulations are carried out; and next, as it would be, if our suggestions were adopted, supposing in either case the number of candidates to be fifty.

Fifty finished paintings, varying from 12 feet by 13 to 15 feet by 12, would involve the artists in expenses (actual outlay) from 30*l*. to 40*l*. each; average, 36*l*.; total in money, 1,800*l*.

In time expended, average 7 months; total 29 years; which, at the low estimate of 150*l*. a-year amounts to 4,350*l*., making the whole outlay equivalent to 6,150*l*.; a positive loss in the aggregate of 5,150*l*. beyond the prize of 1,000*l*.

As pictures so large, all of a given subject, peculiarly treated, and blighted by the vulgar stigma of defeat, stand no chance for sale, but really become a trouble and a nuisance to the artists, we may fairly say that in the aggregate this loss is wholly unmitigated, and that ten such speculative competitions would be equivalent to a loss among them of 50,000*l*. or 1,000*l*. each, or in other words, a total loss of two hundred and ninety years of human life, and 8,000*l*. of the artists' money.

By the mode we would suggest, the loss on the present occasion may be reduced to about 300*l*. in money and 17 years of time; that is, compared with the above, a saving of 525*l* in money, and of nearly 12 years of time and exertion, whilst four or five paintings and twice that number of artists would be held up to distinction, instead of one, who in the ordinary way, engrosses admiration.

On a plan somewhat similar to the double competiton trial, adopted by the French institute at the election for students for residence at Rome, w would have two exhibitions; thus, supposing the number of competitors to be as above, fifty. The first exhibition would be of 50 cartoons, half life size, and 50 studies, of half figures, life size. From these, eight or ten should be rewarded with preliminary prizes. To each the sum of 40*l*. or 50*l*. should be paid, *i. e.* an equal portion of 400*l*. These distinguished candidates are then entitled and invited to compete with each other for the ultimate object. Thus the final great struggle would be between these eight or ten, and the second exhibition would consist of their eight or ten cartoons and studies from their first exhibition, and eight or ten finished pictures full size.

Four or five prizes should be awarded in this competition according to the number of good productions, *i. e.* 200*l*. among them. Thus four or five would receive 40*l*. or 50*l*. each, and as many would have 80*l*. or 100*l*.

Of these twice rewarded four or five, by the final decision, one would receive the great prize of the remaining 400*l*. in addition to his previous rewards, amounting together to 480*l*. or 500*l*. Surely the honour and advantages of such a victory, if properly awarded, would satisfy an ambitious enthusiastic artist. Could any one, amidst the honours and comfort of the glorious harvest, envy his less successful rivals the small return their gleanings had procured them?

By this arrangement the outlay of money and time of the competitors would be,

For 50 cartoons, average 13*l*. and 3 months each	Total £650	and 12½ years.
50 studies, average 8*l*. and 14 days	400	— 2
8 or 10 (say 9) paintings, at 25*l*., and 5 months' average	225	— 2¾
General Total	£1,275	—17¼ years.

Let us now consider the best mode of awarding the prizes, and the way to secure a competent tribunal, without which no good result can be depended on. Much of the difficulty comes from the uncertainty of what is considered excellence in art; some adjudging by the dictates of common sense, untutored to the technical rules of art, others guided almost entirely by conventional technicalites. Again, personal or professional prejudices have not been sufficiently controlled by principles or by responsibility.

The following regulations appear to us entitled to consideration and adoption, viz. the judges should consist of *three*, elected by the parties interested in the purchase; and *three* elected by the artist competitors; in all six persons. They should be elected by ballot after nomination: at least, this rule should be strictly observed in respect to those who represent the artists.

Each of the judges should separately, from others, examine and criticise the performances, and write his opinion of each, and of every work of art; and, naming those which he considers entitled to distinction, give his reasons for that opinion.

These written opinions to be given in previous to the opening of the exhibition to the public; but the result not to be confirmed until a certain number of days after its closing. Then the judges should, for the first time, meet and discuss each other's opinions, and the merits of the competitors; and, recording their matured judgments, decide by the majority; the contrary opinions being also recorded, in order that public opinion be not smothered, as it now usually is, under respect for a supposed unanimous decision.

Gentlemen.—Your committee beg to observe that, in this inquiry, they have considered it of the utmost importance to discuss both sides of every question, and on several occasions, its members have abandoned old favourite views, when the evidence or the argument outweighed a favourite prejudice; they are therefore the more confident in their anticipation of this report meeting with favourable attention, and serious consideration at your hands, and they sincerely hope it may eventually lead to changes equally advantageous to artists, and to the public; to the establishment of regulations more consistent with the immutable principles of equity and good sense, than those which have too often rendered competitions illusive and hurtful; and they trust that apparent difficulties in the operation of a wholesome system, will not weigh against the best interests of humanity, and the progress of the Fine Arts.

French Railways.—The *Journal des Chemins de Fer* publishes the receipts of the French railroad companies for the year 1845, by which it appears that the railroads have produced sufficient to pay a dividend of 6 per cent. on the amount of capital subscribed, besides a prospect of a considerable increase in future years. "This result," observes the journal, "without being extremely brilliant, is sufficiently favourable to encourage investments in railroad speculations; for not only is the increase of the receipts certain, but a reduction in the expense of working them may be expected."

MODEL OF THE PARTHENON.

The principles of pure taste are best taught by examples. One single specimen of the sublime and beautiful will exhibit the nature of it more clearly than whole folios of discussion about the abstract idea. It is for this reason that we must look to the actual restoration of works of ancient architecture, to their original purity as the principal means of elevating the public taste. That architecture has made rapid advances during the last few years, and has attained a higher position than it formerly held in popular estimation, is undeniable; but it is still far from its true place, and not until the works of the architect become, as they once were, works of national importance, not until architecture be restored to perfect purity and be thoroughly purified of all taint of barbarism and all the stains contracted during the debasement of the arts, will those who labour now so zealously for the Revival of the Art, have thoroughly accomplished their great task.

The Parthenon is universally esteemed by the architectural student as *the* exemplar of one of the two great modes of architecture recognized amongst us. The perfection of Classic Art—the complete realisation of its true principles—the last appeal of architectural discussion must be looked for amongst the ruins of the Acropolis—whatever disputes we may have respecting the true spirit of classic architecture must be ultimately settled by reference to this great authority. So that it is impossible to overrate the importance of ascertaining clearly the precise nature of the original architecture of the Parthenon. It is the highest architectural Pandect; the true and right understanding of the code of laws which it embodies must be the sole foundation of all modern Commentaries.

In examining the results of Mr. Lucas's talent and labours now deposited in the British Museum, we criticise a work which is calculated to work an important effect on the public taste. The model of a restoration of the Parthenon, placed where it is universally accessible, affords to the people a type of that of which they possess no actual specimen—pure Grecian architecture. Of the thousands who will inspect this model, there will be scarcely one, even of the most unrefined and uneducated, who will not be led to admire the wonderful beauty of the temple represented—for this is the distinguishing feature (is it not, rightly considered, the being criterion?) of perfect architecture, that its beauties are apprehended by the simplest understanding, and yet for their full appreciation task the energies of the most erudite observer. It may well be imagined that many of those who look with admiration on the representation of the masterpiece of Grecian art will enquire how it comes that we have nothing so perfectly beautiful in our country, as we may reasonably hope that the eye becomes more and more familiar with the principles exhibited in the Parthenon, it will grow more and more dissatisfied with those of modern works in which these principles are most flagrantly violated.

We intend to confine our notice of Mr. Lucas's works to the architectural considerations. A criticism of the elaborate sculpture which the models exhibit does not come immediately within our province, except in so far as the arrangement of the sculpture affects the architecture of the building.

With respect to the external architecture of the Parthenon there are happily but few opportunities for controversy. The remains are in a sufficiently perfect condition to exhibit in a clear and indubitable manner, all the great features of the exterior of the temple. With respect to the interior, however, our knowledge is not so satisfactory. Time and violence have worked so busily within this glorious fane, that now the best evidences of the original design are often no better than mere conjectures. We know the interior of the building was divided into two great chambers, the Opisthodomus or treasury to the west, and the chamber which contained the great statue of Miverva, to the east; but few traces remain of the architecture of these two great divisions of the temple.

In the restoration by Mr. Lucas, the roof of the Opisthodomus is supported from the ground by Ionic columns; the roof of the principal or eastern chamber is supported by a double order of columns, the lower tier Ionic, the upper Corinthian, and for this arrangement Mr. Lucas assigns the following reasons in a small octavo volume, entitled *Remarks on the Parthenon, being the result of studies and inquiries respecting that noble building.*

"In the restoration of the interior, I have adopted that view of the case which is set forth in the seventh volume of the Museum writings, published by the Trustees. Mr. Cockerell has, in that volume, given a restoration which is mainly based on the discovery I have alluded to, of the Corinthian capital in the eastern chamber;* and supposing that this beautiful combination contains the result of all the information on this branch of the subject, I had implicitly adopted it; considerable difference of opinion, however, exists as to the propriety of placing the Doric order over the Corinthian, as Mr. Cockerell has done, or even using the Corinthian at all with propriety. This objection was urged with great force by the celebrated Sicilian antiquary, Le Duo di Serradifalco, on his recent visit to this country. Col. Leake's observations, however, appear conclusive as to the Corinthian order; the Doric over it does not appear to rest on any sure data, as in the Walhalla the caryatides are used instead of the Doric. As this restoration is purchased by the trustees of the British Museum to illustrate the Elgin Gallery, I consider it needful this work should have the advantage of all the recent information that has resulted from the excavations and discoveries of King Otho; and by the kindness of Col. Fox and Major Parker, I am placed in correspondence with the architects of the Walhalla, and also those now employed by the King of Greece at Athens, so that all information will be exhausted in the restoration of the interior. In Inwood's folio work, published in 1827, is engraved plate 22, a portion of a Corinthian capital that was brought by him from the Parthenon, and which he considered a fragment of one of the lower tiers of columns of the interior; and of the fragment, and his restoration from the same, an etching is here presented. †

In regard, however, to the roof of the chamber being open over the statue of the goddess, that question has been much discussed; and it appears probable that the aperture over the statue was filled with some transparent substance, conducing alike to the double purpose of the protection of so costly a work, and rendering its effect mysterious.

NOTE.—The following communications on the subject of the interior of the Parthenon have been obtained from Athens, through the influence of Sir Edmund Lyons, the British Minister at that Court, from Mr. Pittakis, the present Curator of the Parthenon; and also from Mr. George Finlay, who is esteemed a great authority on this matter.

Questions submitted to Mr. Pittakis by R. C Lucas.

1st.—Is the capital of a Corinthian column which Col. Leake alludes to in his work, as having been found in the eastern chamber of the Parthenon (and on which discovery Mr. Cockerell has based his restoration of the lower tier of columns in the interior of the Parthenon) in Athens; or can any account be given of it?

2d.—Can any data be given for the upper tier of columns or support to the roof of the eastern chamber? Mr. Cockerell has used the Doric placed over the Corinthian in his restoration.

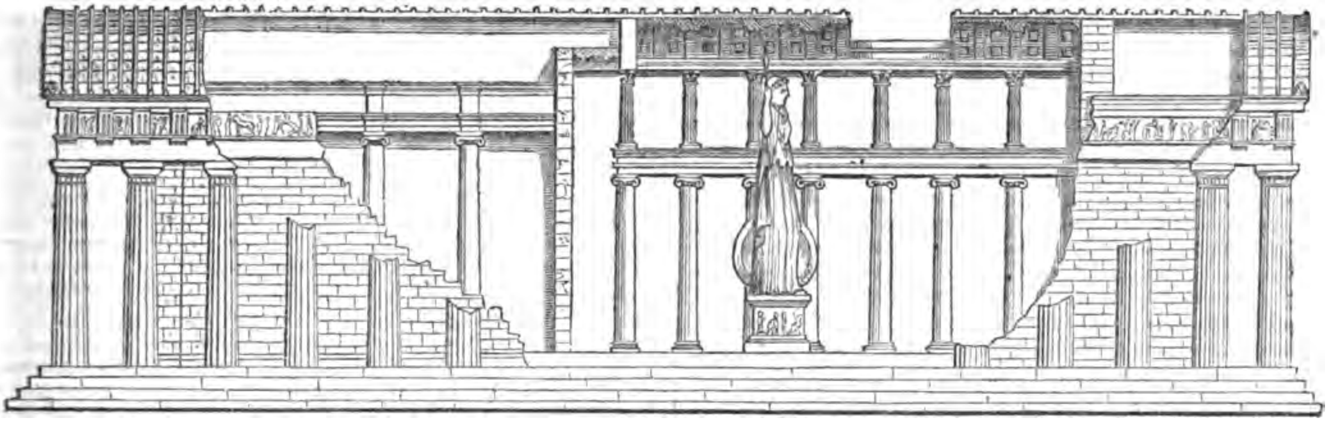
Mr. Pittakis's Answer to Mr. Lucas's Inquiries.

In answer to the first question, around the altar, which was the ancient Hecatompedon, the soil of which is lower than the rest of the Parthenon, appear signs of double columns. The first, which Mr. Cockerell saw, are about three feet in diameter; and thus it has been supposed, wrongly, I think, that those small columns supported the roof of the temple; but when the mosque, which stood on the south side of the temple, was knocked down and cleared away in 1844, traces of columns of five feet in diameter were discovered on the flooring, and are still visible; these columns, which, from their size, were able to support the weight of the roof, were up to the half the height of the Temple of the Doric order; above them was another tier of columns of the Ionic order; so that the lower tier was Doric, and the upper Ionic. The same order of architecture prevailed in the Temple of Minerva. The traces of the Doric order appear in two places, and I have shown the same to several travellers, particularly to Mr. Bracebridge, who may assist in this explanation if referred to. As for the upper range of columns, they were certainly Ionic. This I have ascertained from fragments of this order which I have found in the different excavations I have superintended in the Parthenon; and I also believe that the traces of those columns which Mr. Cockerell gave were made in the time of the Romans, when the Parthenon was restored; and I have found in excavating up to the present period four pieces of the frieze of the Roman era, and they made use of the same upper tier of column—that is, Ionic. As to the second question, six traces of the stylobates exist towards the south of the Parthenon, and four on the north side; but they are of the Roman epoch, as I said before.

I do not agree with Mr. Cockerell in placing the Doric order on the Corinthian; and, if I may be allowed to offer my opinion, I should

* Note.—(From Col. Leake's Work, vol. i. page 334, Second Edition.)—In the eastern chamber of the Parthenon, a Corinthian capital has been found of such dimensions as leads to the belief that the columns were of that order. The smallness of their diameter leaves little doubt that there was an upper range, as described by Pausanias at Olympia, and as still exemplified in one of the temples at Pæstum. In the interior of the temple of Phygalia are two new varieties of the Ionic order, one of which by its helices and leaves of acanthus must be considered as the order afterwards called Corinthian. It proves, therefore, this order was employed in the time of Pericles; in fact, Vitruvius gives the honour of its invention to Callimachus, who lived about that time.

† This restoration, Inwood himself says, is merely ideal. He observes, that there is a peculiarity in the fluting, being different on different sides of the volute. This peculiarity exists also, according to Mr. Cockerell, in the fragments of Corinthian capital in the Temple of Apollo Epicurius, at Phygalia, which was built by Ictinus; but it does not appear that the fragments were similar in other respects, and, even if they did, there is no argument for a range of Corinthian columns in the Parthenon, for in the other temple (that of Apollo, at Phygalia,) the Corinthian column was a solitary one. In "this" case, there is no doubt whatever that the column was a "single" one (not one of a range), and its office was to support the south end of the cellar.



say, that in ancient times, when good taste prevailed in Greece, the Greeks never made use of the Corinthian order to support weights, because this order is only an imitation of flowers, and naturally cannot support anything heavy; they, therefore, used Tripodes, or other architectural ornaments; and used the Corinthian for small, pretty, elegant buildings, such as the Tomb of Lysicrates; but the Romans lost this fine idea, and made the Temple of Jupiter Olympus of the Corinthian order, as also the Gate of Adrian.

From Mr. Finlay to Sir Edmund Lyons.

My dear Sir Edmund,—I have read over Mr. Lucas's questions and Pittakis's replies, and which I now return. The question is one of evidence, and I am not aware that enough exists to decide on how the Parthenon was roofed, or how that roof was supported. There were certain columns; but the very vagueness of Pittakis's conjectures, about which are the Roman restorations, show how much uncertainty reigns concerning the subject. The Corinthian was just as much used to support an entablature as any other order from its earliest existence, as may be proved from many Attic examples.

This subject, therefore, has been discussed, and it appearing probable that in the recent excavations the foundations of the old Parthenon, that exist on the site of the present building, have disclosed traces of the Doric columns that supported the former building; as five feet in diameter is too great for the required height of the lower tier of columns in the interior; and the evidence for the Corinthian order appearing conclusive for the upper tier, as the fragments that Inwood discovered in the Parthenon, from their size, must have belonged to the upper tier, and the size of the Ionic according with the required size of the lower tier, this restoration is now completed with the lower tier Ionic, and the upper of the Corinthian order.

From the above extracts it is obvious that traces of the interior arrangement of the Parthenon are so indistinct as to leave the matter at least a fair subject for controversy. In the sixth volume of the large work published by the Trustees of the British Museum as a catalogue of the Ancient Marbles in the Museum Collection, Mr. Cockerell confesses that the orders of the columns are not clearly ascertainable. We have endeavoured to collect all the principal facts and arguments respecting the internal architecture of the Parthenon, and give them in this place, because, as had been said, no subject can be so important to the architectural student as a precise knowledge of the construction of the great type of Grecian architecture. The reasons for supposing a double tier of columns in the cella of the Parthenon seem to resolve themselves into these two.

1. The presence of the fragments of a Corinthian capital delineated above.

2. Indications in the floor of the interior that columns once stood there of so small diameter that if of proportionate height they would not have reached the roof.

We propose to examine each of these reasons separately. With respect to the first it may, we think, be safely pronounced that the fragments of the Corinthian capital belong to a far more ancient date than the erection of the Parthenon. In Inwood's large folio work, he gives an ideal restoration of the capital to which these fragments belonged, but whether his restoration be correct or not, this is certain that enough of the fragments remain to show that they are to be assigned to an epoch when the arts were in a very different state to that manifested in the building of the Parthenon. Inwood indeed gives a collateral testimony in favour of the hypothesis of a double tier of columns which appears at first very plausible, but which on examination will not be found to have much weight in it. He says that there is a certain peculiarity in which this fragment resembles another found in the temple of Apollo, near Phigalia, which temple was built by the architect of the Parthenon—Ictinus. The point of resemblance between the fragments is this—it is observed in each volute that it is not fluted in the same way on both sides. It does not appear that the resemblance extends any further than this—that the general form and indications of date are the same in both capitals. But even supposing that the similarity were carried much farther than it really is, what does the argument amount to? In two different temples built by Ictinus, we find two columns somewhat resembling each other. But surely this is no proof (of itself) of the existence of a double tier of columns in the Parthenon. For in the other temple built by Ictinus (that at Phigalia), it has never been even surmised that there was a double tier of columns. *Here* it is quite certain what were the purposes and situation of the Corinthian column. It is stood near one end of the cella and midway between the lateral walls, and supported the roof from the ground. It has never been questioned that this column was a *single* one, not one of a range bu standing in the isolated position described, and supporting the centre of the roof by itself. In the case of the Parthenon, however, the circumstances are altogether different, for there the fragments are so small that they could never have belonged to a column which discharged the same office as that at Phigalia. The argument seems therefore reduced to this—if an analogy be made between the two cases, we must infer the use and situation of the one column from the use and situation of the other: and yet from the different sizes of the fragments it is impossible to conceive that they belonged to columns which discharged the same offices.

So that even if it be conceded that the Corinthian column was actually made use of at the Parthenon, the accidental presence of two small fragments seems but scanty data for the supposition of a whole order. To the objection that the Parthenon fragments are of a date anterior to the temple itself, it may be replied that perhaps some of the materials of the old Parthenon were used up in the construction of the new. (For the Parthenon now existing is the second temple built on the same site; its predecessor, the ancient Hecatompedon having been destroyed during the invasion of Xerxes, and the stones of it having been carried away to make military fortifications.) Now it is scarcely to be supposed, the old temple having been violently destroyed, and the materials of it used for fortification, that at a subsequent period part of those materials (namely, the columns and their capitals) would be found so perfect as to be worthy of being used again in the building of the new temple, which was to be the wonder of Greece. There is every reason for thinking that the Athenians were determined that the new Parthenon should be, what in truth it is, the most perfect specimen of Grecian art. The construction and decoration of it taxed the energies of the greatest artists and sculptors of that age, and not only the Athenians but the whole Grecian race looked to the perfect completion of it with the greatest interest. Is it then to be supposed that the poor economy of using up old materials would be readily allowed under any circumstances? And is it not in the highest degree improbable that columns would be employed which in the important points of their orders and their dates differed from the other columns of the temple, and which had moreover suffered all the mutilations inevitable in the rough usages of warfare?

2. The second argument for the upper tier of columns is that traces have been found in the pavement, from which it is concluded that columns of small diameter once stood there—so small that the columns could not have

been high enough to reach the roof. This certainly is a more formidable argument than the last; it shows that if columns corresponding to these indications actually existed, there must have been another order of columns or some other architectural members between them and the roof. This conclusion seemed perfectly unavoidable when Professor Cockerell wrote; but we seem now relieved from all necessity of a supposition of the kind by the subsequent discovery of traces of larger colums *which would have reached the roof*. There seems no reason whatever for supposing that these columns rather than the small ones were vestigies of the old Hecatompedon. It may be conceded that such traces would remain of the foundations of the first building as would exhibit the position of its columns; and there is no great improbability in supposing that these traces would not be wholly effaced by the erection of the new Parthenon.—We ourselves have repeated experience of the same state of things in our own mediæval edifices. But there seems no reason for preferring the small columns to the large ones as having been those actually constructed in the new Parthenon. If either set of remains are to be assigned to the previous building, we have a perfect right to choose which we please—so that there is no absolute *necessity* for supposing that the small columns rather than the large were those of the Parthenon.

But there are several general considerations of a very weighty nature which lead us irresistibly to choose the larger columns reaching from the pavement to the roof as the set actually belonging to the Parthenon. In the sixth volume of the work on the Museum collection of marbles, already referred to, Mr. Cockerell gives a representation of the interior of the temple restored; his drawing resembling the illustration of the present article, excepting in the orders of the columns. Now it will be observed that in Mr. Cockerell's drawing, and also in the woodcut here given, the ower order of columns of the cella are between *two and three times* the height of the upper order. It seems to us perfectly impossible that such an arrangement could have actually existed. The upper range of columns would be considerably less than half the size of the lower range, and consequently one of these two things must have occurred—either the upper columns must have been constructed in total defiance of all due proportion of their height to their diameter (a deformity which such an architect as Ictinus could never have permitted), or else the columns of the upper tiers must have been of less diameter as well as less height than those of the lower tier—an arrangement as awkward and ungraceful as can possibly be imagined; for the intercolumniation ought to be proportionate to the diameter of the columns, and here we should have the large columns of the lower tier and the small upper columns arranged at the same distances from each other.

This objection appears perfectly fatal to the existence of the upper range. It may be added that, viewed quite independently, the second tier of columns is but a poor make-shift contrivance for getting additional height, and one which we should never attribute to the architects of the Parthenon. The whole building—that is, where the architecture is clearly determined—exhibits a perfect simplicity and oneness of design, totally at variance with this supposition, for which we have shewn that there is no *absolute necessity*, and against which there are so many powerful *a priori* arguments. In the exterior of the temple the columns were all of one order, and all supported the roof from the ground: if, in examining Mr. Lucas's beautiful model, the observer will imagine that the same arrangement was observed in the interior of the building, he will, we think, be disposed to agree with us, that the beautiful symmetry and unity of the whole is greatly enhanced on this supposition.

If we suppose the great chamber of the temple supported by a magnificent range of lofty columns rising to the roof, the mind instantly pictures a noble interior, harmonising in its severe and simple beauty with what the eye has been taught to expect by surveying the exterior of the building. If, on the contrary, we suppose in the interior a range of diminutive columns supporting others still smaller than themselves, our preconceived notions of the dignity and simplicity of the Parthenon are entirely overturned, and we are forced to allow that the Greeks themselves gave a precedent for the later parodies and barbarous adaptations of their beautiful architecture.

There is good reason to hope that before long this matter will be settled beyond all dispute. Mr. Lucas is far too energetic a lover of the arts to leave his task half done. He purposes to show shortly the very scenes of which he has furnished so admirable representations, for the purpose of examining, in the minutest manner, all that remains of the Parthenon, and of clearing up, as far as possible, all controversies respecting it. All disciples of true architecture will await the true result of his mission with interest, as tending to elucidate points of the very highest architectural importance. It may not be inopportune to call to remembrance that the distinguishing characteristic of Grecian architecture is *unity* and *simplicity*, and that therefore, in all cases of doubt, we should lean to the opinion which favours the simplest form. In nothing is the *simplex munditiis* so admirably developed as in pure classic art, as distinguished from the subsequent imitations of it; and therefore it is by following up those traces which are indicative of the greatest simplicity, that difficulties are most likely to be unravelled. With this hint we quit the subject, thanking Mr. Lucas for the valuable information which he has personally communicated, and congratulating him cordially, not only on the accession of fame which his models will win for him, but on having completed a work which will have the most powerful effect in elevating the public taste for *true* classic architecture.

ON SACRISTIES.

Very little has ever been said on the subject of Sacristies, or, as they are more usually called now, Vestries, in the Ecclesiologist. Yet it may be doubted whether such an appendage is not absolutely necessary to a church; from the impossibility of dispensing with its use, if the Divine offices are to be performed with any ceremonial, not to say decency. For not only is a receptacle required for the ornaments of the altar, the church, and the clergy, but it can scarcely comport with seemly reverence for any change of vestment to take place in the presence of an assembled congregation: the high pews in the chancel, which used often to hide this process in mean country churches, having by this time pretty generally disappeared; and the device of screening off a part of the area of the church being now fitly regarded as an expedient scarcely justifiable under any emergency.

It is not difficult to derive a general rule for the right position, and for several important details of the arrangement of Sacristies from observation of our old churches. For although existing ancient examples are far from numerous, yet in a large proportion of untouched chancels, we may observe unmistakeable traces of Sacristies which have been destroyed. From these we deduce that the proper situation of a Sacristy is on the north side of the chancel, towards its eastern part. The reasons for this position are obvious: it is near the altar (to the service of which the Sacristy, like the rigidly prescribed *Diaconicum* in a Greek church, more especially belongs); the door into it falls conveniently between the end of the northern stalls and the steps of the sacrarium, the south side being pre-occupied by piscina, sedilia, and the priest's entrance; and perhaps its presence, always rather intrusive, is less so on the north than it would be if it marred the southern prospect of the church, which in our climate is, as a general rule, in an inoffensive sense, the *show* side.

Ancient Sacristies remain in the above situation at S. Nicolas, Southfleet, Kent; S. Swithin, Leadenham, Lincolnshire; S. Mary, Reigate, Surrey, where there is a north chancel-aisle; S. Andrew, Backwell, Somerset. Sacristies in the same position once existed in SS. Mary and Michael, Trumpington; All Saints, Teversham; S. Mary, Fen Ditton, Cambridgeshire; S. Mary, Stone, Kent; and S. John, Shottesbrook, Berks. These examples are taken at random. External corbels on the north chancel-wall; the absence of windows in that part; the presence of a north chancel door, generally blocked, (in addition to the priest's door), the outer mouldings of which will often be found to be not of an external character; and foundations discovered in digging graves; reveal the former existence of a Sacristy, and are peculiarities not explained by any other supposition. In some few cases these may be traces of a chantry chapel; much more generally, however, of a Sacristy, allowed to fall to ruin, or destroyed, by the holder of the great tithes. Again, chantries, more especially detached ones, belonged generally to manors, and contained monuments, for the sake of which they have been preserved. Chantries also opened to the church by arches, not by a small door; so that we may conclude the marks mentioned above to be true signs of a Sacristy, not of a chantry chapel.

Before we leave the question of position, we must condemn the practice of some architects who, having partly received the rule we are laying down, have placed their Sacristies at the *western* part of the north side of the chancel, in the angle between the north aisle and the chancel. Certain advantages seem to be gained by this alteration: it is particularly convenient for a concealed winding staircase to the pulpit; it avoids an awkward corner on the outside; it allows of the door being placed so far west as not to interfere with the altar space, which is felt to be a gain now, considering that so many lay people resort to the Sacristy. Nevertheless, independently of the argument from authority, we prefer the old arrangement, by which the proximity of the Sacristy to the altar is maintained, the east window of the north aisle is preserved, a better distribution of light in the chancel is gained, and the stalls on the north side are left free. In a word, we think it will be *felt* that this arrangement harmonizes more with the disposition and keeping of an old church; and very often the feeling of a thoughtful observer of our old churches is worth attention, even though he may find it difficult or impossible to describe in words the nature of, or the reasons for, his impression.

We are aware that examples may be found of Sacristies built in the middle, and not at the eastern part, of the north side, as at S. Margaret's, Leicester, where it occupies the middle of the three bays composing the north chancel-aisle; or even of Sacristies in the middle bay of the south side, as at All Saints, Maidstone, Kent; but this is the case, perhaps exclusively, in Third-Pointed churches, and those of a more dignified kind than the class we are now considering. The eastern end of the north side will be found, we believe, the usual place in moderate churches of the Middle-Pointed period.

Another position, sometimes chosen in modern times, is to be severely reprehended. The Sacristy ought not to be eastward of, or behind, the altar, whether it be made by advancing the altar and reredos and leaving a screened space between it and the east wall, as at Holy Trinity, Cambridge, or by building a semicircular apse for it, as at Emmanuel church, Camberwell. We are aware that some have held that the apsidal Romanesque churches in this country were originally so fitted: at S. John, Little Maplestead, Essex, the arrangement remains: we answer, that even were this the case, which we do not believe, both the Romanesque style and the apse itself have passed away, and the Camberwell parody perhaps did not deserve mention.

Having thus settled the right position of the Sacristy, we will mention a few further particulars respecting this part of a church. We believe that generally it *ought* to have a lean-to roof, to distinguish it from a chantry, which, more often, if not always, has a gable. We are not sure that a separate gable is ever to be recommended, where there is no altar; for example, in aisles: the picturesqueness of three gables is, we are confident, a snare to some of our best modern architects. Still, if the Sacristy runs at right angles to the axis of the church, instead of parallel to it, a gable may be allowed; but this arrangement is not to be encouraged.

The details in the Sacristy may be of a less ecclesiastical character than those admitted into the church itself. Authority for this is found to a limited degree in the instances above; the church of S. Mary, Oberwesel on the Rhine, and S. Leonhard, at Frankfort-on-the-Maine, are examples in point. It may be questioned whether this licence is to be extended to more dignified churches. We cannot object to a fireplace and a chimney in a Sacristy: let them be boldly and undisguisedly treated. Still we are not sure that a too secular style has not been sometimes admitted.

Respecting large or town churches, the rules are not so stringent. In these the Sacristies may be in any convenient situation; of course, nearer the altar than otherwise. Thus at S. Mary, Redcliffe, they are on the north side, and have an upper story of rooms fitted for residence; in the abbey church of S. Mary, Tewkesbury, they are beautifully vaulted apartments to the south. In such churches the Sacristy ought to glow with colour and ornaments no less than the more sacred parts of the building. The Sacristies at S. Miniato, Florence, and Sta. Maria Gloriosa de' Frari, Venice—the first south of the south chancel-aisle, the latter south of the south transept—are remarkable examples. S. Anastasia, Verona, has a noble Sacristy, north of the north transept. The Duomo, at Milan, has Sacristies north and south; an arrangement adopted, not unhappily, in S. Paul's, London. At Cologne they lie to the north; and the detached Sacristies at S. Peter's, Rome, lie also to the north of the north transept. On the whole the north, for dignified churches also, is the better side. The Vestries of the churches in London built after the great fire—which provoke many a sneer from superficial observers for their supposed *comfort*—are rather to be regarded as instances wherein the architects have mastered the true idea of what they were building; placing it where most convenient, fitting it for its various uses, (unfortunately not solely religious ones,) and making it a not unworthy appendage to their costly churches. It was neither practical skill, nor boldness, nor *animus* that was wanting to our then architects. The Paganism of their age spoilt it all.

And this consideration leads us naturally to observe the importance of an architect's clearly mastering the idea of what he is going to design before he begins. There is no part of a church which has not its peculiar use, and ought not therefore to have a peculiar character. One does not see how a northern or southern porch could be otherwise than a gabled building, with its axis at right angles to the church. Again, nothing can be more distinct, or peculiarly appropriate to its use, than the character of a chapter-house. Similarly, a chantry, or an aisle with eastern altar, would seem to require a gabled roof: a lean-to roof, again, befits the subsidiary use of a Sacristy. The selection, then, of the detached chapter-house form for the Sacristy at a new church at Keswick, and at S. John Baptist's, Eastover, was a great mistake arising from a want of discrimination between the two kinds of building. But a less pardonable confusion of ideas is to be observed in the restoration of S. Martin's, Canterbury, where a nondescript building, part aisle, part chantry, is added as a Sacristy, and a cellar for the stove, towards the western part of the north side of the chancel. It is a great mistake also to build parvises for Sacristies. The position is most inconvenient, besides that the parvis had, and might have again, an appropriate use. Nor can this use of an ancient parvise be well defended, even where the sacristy has perished. This was the case at Kemerton, Gloucestershire, and led perhaps to the blocking up of the priest's door in that church. We have seen a modern design in which the chancel is raised and a Sacristy formed like a crypt below it. It is conceivable that great peculiarity of site might justify this arrangement; but it is not to be recommended.

It will be at once seen that if our observations be true, few devices are more essentially objectionable than one we have often deplored; namely, the use of a building, opening to the church, aisle-wise or chantry-wise, by an arch, and parclosed off for a Sacristy, the organ perhaps being placed above. It is altogether a confusion of ideas.

Any secular uses of a vestry are so incompatible with the religious ones, that we cannot conceive any arrangement which shall unobjectionably suit the two combined. We have confined ourselves to pointing out the best course to adopt with reference to the Sacristy considered only in its higher use.—*Ecclesiologist.*

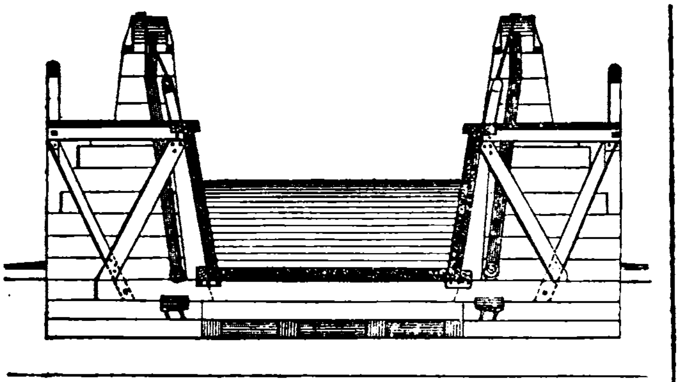
SUSPENSION AQUEDUCT OVER THE ALLEGHENY RIVER, PITTSBURGH.

This work, recently constructed under the superintendence of John A. Roebling, the designer and contractor, has supplied the place of the old wooden structure which originally was built by the State of Pennsylvania at the western termination of the Pennsylvania Canal.

The Council of the city of Pittsburgh, by whom, in consequence of an arrangement with the State, the tolls on this aqueduct are of late received, and who are bound to keep the work in repair, decided on re-building, and after considering various plans, adopted that of Mr. Roebling, and entered into contract with him to re-construct the communication, for the gross sum of 62,000 dollars, including the removal of the old ponderous structure and the repair of the pier and abutments; a very small sum indeed for a work of such magnitude. As this work is the first of the kind ever attempted, its construction speaks well for the enterprize of the city of Pittsburgh.

The removal of the old work was commenced in September, 1844, and boats were passed through the new aqueduct in May, 1845.

This work consists of 7 spans, of 160 feet each, from centre to centre of pier. The trunk is of wood, and 1,140 feet long, 14 feet wide at bottom, 16½ feet at top, the sides 8½ feet deep. These as well as the bottom, are composed of a *double* course of 2½ inch white pine plank, laid diagonally, the two courses crossing each other at right angles, so as to form a solid lattice-work of great strength and stiffness, sufficient to bear its own weight, and to resist the effects of the most violent storms. The bottom of the trunk rests upon transverse beams, arranged in pairs, four feet apart; between these, the posts which support the sides of the trunk are let in with dove-tailed tenons, secured by bolts. The outside posts, which support the sidewalk and tow-path, incline outwards, and are connected with the beams in a similar manner. Each trunk-post is held by two braces, 2½ × 10 inch, and connected with the outside posts by a double joist of 2½ × 10. The trunk-posts are 7 inches square on top, and 7 × 14 at the heel; the transverse beams are 27 feet long, and 16 × 6 inches; the space between the two framings is 4 inches. It will be observed, that all parts of the framing are double, with the exception of the posts, so as to admit the suspension rods. Each pair of beams is supported on each side of the trunk by a double suspension rod of 1⅛th inch round iron, bent in the shape of a stirrup, and mounted on a small cast-iron saddle, which rests on the cable. These saddles are connected, on top of the cables, by links, which diminish in size from the pier towards the centre. The sides of the trunk set solid against the bodies of masonry, which are erected on each pier and abutment as bases for the pyramids which support the cables. These pyramids, which are constructed of 3 blocks of a durable, coarse, hard-grained sand-stone, rise 5 feet above the level of the sidewalk and tow-path, and measure 3 × 5 feet on top, and 4 × 6½ feet at base. The side-walk and tow-path being 7 feet wide, leave 3 feet space for the passage of the pyramids. The ample width of the tow and foot-path is therefore contracted on every pier, but this arrangement proves no inconvenience, and was necessary for the suspension of the cables next to the trunk.



The caps which cover the saddles and cables on the pyramids rise 3 feet above the inside or trunk railing, and would obstruct the free passage of the tow-line; but this is obviated by an iron rod which passes over the top of the cap, and forms a gradual slope down to the railing on each side of the pyramid.

The wire cables, which are the main support of the structure, are suspended next to the trunk, one on each side; each of these two cables is exactly 7 inches in diameter, perfectly solid and compact, and constructed in one piece from shore to shore, 1,175 feet long; it is composed of 1,900 wires of ⅙th inch thickness, which are laid parallel to each other. Great care has been taken to insure an equal tension of the wires. Oxidation is guarded against by a varnish applied to each wire separately, their preservation, however, is insured for certain by a close, compact, and continuous wrapping, made of annealed wire, and laid on by machinery in the most perfect manner. A continuous wrapping is an important improvement, which, in this case, has been for the first time successfully applied.

A well-constructed and well-wrapped cable presents the appearance of a solid cylinder, which in strength greatly surpasses a chain, made of bars of the same aggregate section or weight. It is not only the great relative strength of wire which renders it superior to bar iron, but its greater elasticity, which enables it to support strong and repeated vibrations, add still more to its value as a material for bridge building.

The extremities of the cables do not extend *below* ground, but connect with anchor chains, which, in a curved line, pass through large masses of masonry, the last links occupying a vertical position. The bars composing these chains average 1½ × 4 inch, and are from 4 to 12 feet long; they are manufactured of boiler scrap and forged in one piece without a weld. The extreme links are anchored to heavy cast-iron plates of 6 feet square, which are held down by the foundations, upon which the weight of 700 perches of masonry rests. The stability of this part of the structure is fully insured, as the resistance of the anchorage is twice as great as the greatest strain to which the chains can ever be subjected.

The plan of anchorage adopted on the aqueduct varies materially from those methods usually applied to suspension bridges, where an open channel is formed under ground for the passage of the chains. On the aqueduct, the chains below ground are imbedded and completely surrounded by cement. In the construction of the masonry, this material and common lime mortar have been abundantly applied. The bars are painted with red lead. Their preservation is rendered certain by the known quality of calcareous cements to prevent oxidation. If moisture should find its way to the chains, it will be saturated with lime, and add another calcareous coating to the iron. This portion of the work has been executed with scrupulous care, so as to render it unnecessary on the part of those who exercise a surveillance over the structure to examine it. The re-painting of the cables every two or three years will insure their duration for a long period.

Where the cables rest on the saddles, their size is increased at two points by introducing short wires, and thus forming swells, which fit into corresponding recesses of the casting. Between these swells, the cable is forcibly pressed down by three sets of strong iron wedges, driven through openings which are cast in the side of the saddle.

When the merits of the suspension bar were discussed previous to the commencement of the structure, doubts were raised as to the stability of the pyramids and the masonry below, when unequal forces should happen to disturb the equilibrium of adjoining spans. It was then proved by a statistical demonstration, that any of the arches with the water in the trunk could support an extra weight of 120 tons, without disturbance to any part of the work. In this examination, no allowance at all was made for the great resistance of the wood-work and the stiffness of the trunk itself. During the raising of the frame-work, the several arches were repeatedly subjected to very considerable unequal forces, which never disturbed the balance, and proved the correctness of previous calculations.

The stiffness and rigidity of the structure is so great, that no doubt is entertained that each of the several arches would sustain *itself* in case the wood-work of the next one adjoining should be consumed by fire. The wood-work in any of the arches separately may be removed and substituted by new material, without affecting the equilibrium of the next one.

The original idea upon which the plan has been perfected, was to form a *wooden trunk*, strong enough to support its own weight, and stiff enough for an aqueduct or bridge, and to combine this structure with wire cables of a sufficient strength to bear safely the great weight of water.

The plan of this work, therefore, is a combination which presents very superior advantages, viz., *great strength*, *stiffness*, *safety*, *durability*, and *economy*.

This system, for the first time successfully carried out on the Pittsburgh aqueduct, may hereafter be applied, with the happiest results, to railroad bridges, which have to resist the powerful weight and great vibrations, which result from the passage of heavy locomotives and trains of cars.

Remark.—The quantities in the following table are calculated for a depth of water of 4 feet, which has been in the aqueduct ever since the opening. The depth contemplated was 3½ feet; a greater depth is at present required on account of the raising of the bottom of the canal by bars and sediment, which have to be removed before the level can be lowered.

Table of Quantities of the Aqueduct.

Length of Aqueduct without extensions 1,140 feet.
Length of cables, 1,175 feet.
Length of cables and chains, 1,283 feet.
Diameter of cables, 7 inches.
Aggregate weight of both cables, 110 tons.
Section of 4 feet of water in trunk, 59 sup' feet.
Total weight of water in aqueduct, 2,100 tons.
" " one span, 295 tons.
Weight of one span, including all, 4[illegible]0 tons.
Aggregate number of wires in both cables, 3,800.
Aggregate solid section of both cables, 53 sup. inches.
" " anchor chains, 72 sup. inches
Deflection of cables, 14 feet 6 inches.
Elevation of pyramids above piers, 16 feet 6 inches.
Weight of water in 1 span between piers, 275 tons.
Tension of cables resulting from this weight, 392 tons.
Tension of one single wire, 206lb.
Average ultimate strength of one wire, 1,100 lb.
Ultimate strength of cables, 2,090 tons.
Tension resulting from weight of water upon one solid square inch of wire cable, 11,800 lb.
Tension resulting from weight of water upon one square inch of anchor chains, 11,000 lb.
Pressure resulting from weight of water upon one pyramid, 137½ tons,
" " " " one superficial foot, 18,400 lb.

COLOGNE CATHEDRAL.

It appears from the forty-ninth Report of the Committee of the Society for the Restoration of Cologne Cathedral, that the advance made during the period embraced in the present Report consists, on the south side, in the additional height to which the pier of the transepts have been carried. In the same part, the western entrance has been completely vaulted in, and the eastern begun to be so. A great quantity of stone is lying ready cut for the work, and still more is expected from the quarries, in order, if possible, to vault-in the middle space also before the end of the year.

Similarly, only somewhat further, advanced are the works in the north transept. Here the three spaces are for the most part already vaulted over, and they will at all events be quite completed in the course of the present autumn.

The works in the northern nave aisle were put in activity immediately after the illustrious visit of Queen Victoria, it being necessary that the old roofing should be retained till up to that time. This has now been removed, and scaffolding is in course of erection in order to set to work upon the new vaulting. Seven bays of original vaulting, as is well known, already existed on the north side; so that there remained but five to construct. But on the removal of the old roofing and woodwork, the south-eastern pillar of the seventh bay was discovered to be built of brick in the most slovenly and insufficient manner. The groining bands and ribs of tuffstone springing from it were in the same way most meanly put together, the lines broken so as to form polygons, and the joints very faulty. Still, supposing this defect could have been partly discovered from below by the naked eye, and the conclusion thence arrived at that this vaulting was of later origin than the other portions of the beautiful vaulting of the cathedral, with which it admitted of no comparison, this would not have prevented it from being retained from antiquarian considerations, had the previously-concealed pillar proved at all adequate to support the pressure of the mass rising from it to the additional height of ninety feet and more.

This not being the case, this pillar and the vault belonging to it had to be given up to destruction. This is at present being accomplished, and the construction of the remaining spaces of vaulting suffers some delay in consequence. In general, the works will be carried on uninterruptedly with about four hundred men. Meanwhile the supply of stone is by no means kept up with the regularity to be desired, notwithstanding the arrangements have been entered into with ten different contractors. There is considerable difficulty in procuring stone of good quality in a sufficient quantity; and even were these stones obliged to be delivered in all at once according to given dimensions, the due succession would not be always observed, as the quarry-men work out the material only as it can be procured to best advantage from the rock.

At a previous meeting of the Committee, the following order of the King of Prussia was read:—

"I have received the report of the Central Restoration Society's operations during the last three years, transmitted to me the 2nd of last month, and have taken cognizance of its contents with true satisfaction. From it I perceive with pleasure the constantly growing sympathy for the grand object of the Society in most of the provinces of Germany, and am much gratified in recognising the credit which the Society's Committee has gained itself by its wise and strenuous conduct of the concerns entrusted to its care. The judicious administration and application of the resources placed at its disposal are sufficiently attested by the performances of the Society during the short period of its existence. These fully answer every reasonable expectation, and justify a still higher confidence in the successful prosecution of this sacred and noble work. To promote this success to the utmost of my power and with undiminished interest, forms one of the objects to which my life will be devoted."

FREDERICK WILLIAM.

Sanssouci, Sept. 1, 1845

To the Central Society for the Restoration of Cologne Cathedral.

The total receipts of the Society amount to about 22,180*l.*

BROAD AND NARROW GAUGE EXPERIMENTS.

We are indebted for the following particulars of the experiments made before the *Gauge Commissioners* to the Morning Herald, at present the official account has not been published.*

BROAD GAUGE EXPERIMENTS.

Miles.	STATIONS.	First Day. First Trip. 8 Carriages of 10 tons each, 81 tons 18 cwt. gross wht. exclusive of engine and tender. Down. a.m. h. m.	First Day. First Trip. Up. p.m. h. m.	First Day. Second Trip. 7 Carriages of 10 tons each, 71 tons gross weight exclusive of engine and tender. Down. a.m. h. m.	First Day. Second Trip. Up. a.m. h. m.	Second Day. With 6 carriages and gross weight 60 tons exclusive of engine and tender. Down. a.m. h. m.	Second Day. Up. a.m. h. m.
	Started from						
	Paddington	9 58¾		2 4½		10 2½	1 4
	First mile post	10 2½	1 4½	2 8½	4 51	10 6½	1 0
	West London crossing rly	10 6½	1 2½	2 12	4 50	10 0	12 59
5¼	Ealing	10 11	12 59	2 16	4 47	10 14	12 56
7½	Hanwell	10 13	12 57	2 18	4 45	10 16½	12 54½
9	Southall	10 14¾	12 55½	2 20½	4 43½	10 17½	12 52
13	West Drayton	10 20	12 50½	2 25½	4 39	10 22½	12 47½
18	Slough	10 25½	12 44½	2 31	4 34	10 27½	12 42½
22½	Maidenhead	10 30½	12 40	2 36	4 29½	10 32	12 38
30¾	Twyford	10 40	12 31	2 46½	4 21½	10 40½	12 29
35¾	Reading	10 46	12 26	2 52	4 16	10 46	12 24
41½	Pangbourne	10 52½	12 20	2 58½	4 10	10 52	12 20
44¾	Goring	10 56½	12 16	3 2½	4 6	10 55½	12 15
47½	Wallingford Road	11 0	12 13	3 6	4 4½	10 59½	12 11½
53	Didcot	11 6½	12 4½	3 12	3 54½	11 5	12 3
	Total time on the road	1 4	1 1½	1 8½	0 56½	1 2½	0 59

Gradients.

From ¼ to 2¼ rise 3 feet per mile.
2¼ .. 7½ „ 4 ditto.
7½ .. 9¾ „ 4 ditto.
9¾ .. 10½ level.
10½ .. 12¾ fall 4 feet per mile.
12¾ .. 15¼ level.
15¼ .. 17½ fall 4 feet per mile.
17½ .. 20 rise 2 feet per mile.

From 20 to 23 rise 4 feet per mile.
23 .. 32¾ „ ditto.
32¾ .. 36½ fall ditto.
36½ .. 42 rise ditto.
42 .. 43 level.
43 .. 44 rise 2 1-10th per mile.
44 .. 53 rise 4 feet per mile.

On Saturday morning, January 10, two more experimental trips were made on the broad gauge (the Great Western Railway) in the presence of the Gauge Commissioners; the weather was rather unfavourable, the morning being dull and damp, and very little wind stirring until the afternoon. The Hercules was again selected for the purpose; it is a powerful engine, having connected wheels 5 feet in diameter, cylinder 16 inches, stroke 18 inches, and weighs 22 tons. At 7h. 52m. 24s. she started from the one mile post, Paddington, with a train of 18 trucks, coal-laden, an additional tender, and a first class carriage, which was occupied by Sir F. Smith, Professor Barlow, Mr. Watson, Mr. Saunders, secretary to the company, Mr. Harmer, and Mr. Gibson; on the engine were Mr. Brunel, engineer of the line, and Mr. Gooch, superintendent of the locomotive department. This experimental train was driven from Paddington to Didcot, a distance of 52¾ miles, where it arrived at 10h. 19m. 38s. having made stoppages at Ealing, Southall, West Drayton, Slough, Maidenhead, Twyford, and Goring. For the exact time of arrival and departure from the several stations the reporter has been indebted to Mr. Seymour Clarke, the principal superintendent of the line, and it is as follows:—

Miles from Paddington.		Arrival. h. m. s.	Departure. h. m. s.	Stoppage. h. m. s.
	Paddington	..	7 52 24	—
5¼	Ealing	8 4 53	8 7 42	0 2 49
7½	Hanwell	8 12 36	—	—
9	Southall	8 16 52	8 20 41	0 3 49
13	West Drayton	8 35 25	8 40 33	0 5 8
18	Slough	8 51 38	8 55 43	0 4 5
22½	Maidenhead	9 6 41	9 11 32	0 4 51
30¾	Twyford	9 28 33	9 33 44	0 5 11
35¾	Reading	9 44 42	—	—
41½	Pangbourne	9 54 8	—	—
44¾	Goring	10 0 8	10 2 0	0 1 52
47½	Wallingford-road	10 9 30	—	—
52¾	Didcot	10 19 38	—	—
		Total stoppage ..		0 26 55

The distance was accomplished in 2h. 27m. 14s., or at a rate of 26·75 miles an hour. The weight of train propelled, exclusive of the engine, was 204 tons 18 cwt. 1 qr. 3 lb. Soon after the arrival of this train at Didcot, the Ixion, a powerful passenger engine, having driving wheels 7 feet in diameter, came up with a train of 15 trucks, laden with coal, to be attached to the train of the Hercules, making in all 28 trucks and one first class carriage. After all matters were arranged this leviathian train proceeded on its journey; its weight, length, and the time it passed the different stations, are given from the same authority as that of the down trip:—weight 406 tons, 3 cwt. 1 qr. 10 lb.; length of train, 232 yards.

	From Paddington. Miles.	h. m. s.
Started from Didcot	53	1 22 15
— Wallingford-road	47½	1 36 0
— Goring	44	1 49 0
— Pangbourne	41½	1 57 0
— Reading	35¾	2 8 30
— Twyford	30¾	2 22 15
— Maidenhead	22½	2 41 0
— Slough	18	2 51 0
— West Drayton	13	3 7 0
— Southall	9	3 23 0
— Hanwell	7½	3 25 0
— Ealing	5¼	3 29 0
Arriving at the 1¼ mile-post from Paddington	—	3 39 0

Performing the journey in 2h. 16m. 45s., at an average rate of speed of 23 miles an hour.

The duration of this trip was 54 minutes, 6 seconds, which shows a speed of upwards of 47½ miles per hour. The maximum rate, between the 18th and 19th mile-posts, was somewhat above 54 miles per hour.

NARROW GAUGE EXPERIMENTS.

The experiments for testing the tractive capacity of the narrow-gauge engine commenced on the 30th Dec. last, upon the Great North of England line, between York and Darlington. The distance run was that between the first and forty-fourth mile-posts—viz. 43 miles. This piece of railway has been selected in consequence of its being nearly a direct line throughout its whole course, and from the very easy character of its gradients. The engine selected is a new one, recently constructed, made at the celebrated locomotive establishment of Mr. Robert Stephenson. She had been running for about a week only, and had not made any except experimental trips. Her performances were considered to be so good that she was fixed upon as the champion for the narrow-gauge interests. She is a six-wheel engine, with outside cylinders; has 6 feet 6 inches driving wheels, and the top of her boiler is about 7 feet 4 inches from the rails.

The hour fixed for the starting of the train was nine o'clock. There were present to witness the experiment Professor Barlow, Professor Airy (two of the gauge commissioners); Mr. Watson, the secretary to the commission; Mr. G. Hudson, M.P.; Mr. Richardson, the mayor of York; Mr. Brunel; Mr. C. A. Saunders, the secretary of the Great Western company; Mr. Gooch, superintendent of the locomotive department in the same company; Mr. Bidder; Mr. Cabry, the engineer of the York and North Midland; Mr. Harrison, the engineer of the Great North of England; Mr. W. Stevenson, of the Great Western Company; Mr. Wyndham Harding; Mr. Berkeley of Mr. Robert Stephenson's establishment, and several other scientific gentlemen.

The weight of the train was 50 tons only, and that of the engine and tender together about 28 tons. The weights of the experimental trains

* The first experiments were made in the middle of December last on the Great Western Railway. The Hercules locomotive engine was selected for the purpose.

upon the broad gauge were (exclusive of engine and tender) fixed at 80 tons, 70 tons and 60 tons, but the actual tonnages were 81 tons 18 cwt., 71 tons 12¾ cwt., and 61 tons 0 cwt. 2 qrs. It will be seen, therefore, that the experiment upon the narrow-gauge line, the particulars of which we are about to detail, has no parallel working upon the broad-gauge railway; and that whatever the value of the result, it can be recognized only when the broad-gauge engine shall have taken the same reduced tonnage for the same distance.

STARTING.—At 9h. 7m. 15s. the train started from the station in order to proceed to the first mile-post, from which it had been understood the experiment was to commence. Upon the Great Western line the experimental trains left the Paddington terminus, and were brought to a stand-still at the first mile-post. This, however, was not the case this morning.

The train passed the—

Train passed	h.	m.	s.	Time each mile. m.	s.	Train passed	h.	m.	s.	Time each mile. m.	s.
1st mile-post at	9	12	17	0	0	23rd mile-post at	9	47	50	1	25
2	9	14	25	2	8	24	9	49	35	1	45
3	9	15	45	1	20	25	9	51	35	1	55
4	9	17	0	1	15	26	9	53	20	1	50
5	9	18	12	1	12	27	9	55	15	1	55
6	9	19	20	1	8	28	9	57	15	2	0
7	9	20	30	1	10	29	9	59	12	1	57
8	9	21	40	1	10	30	10	1	28	2	16
9	9	23	2	1	22	31	10	3	30	2	2
10	9	24	32	1	30	32	10	5	15	1	45
11	9	26	15	1	43	33	10	6	50	1	35
12	9	28	8	1	53	34	10	8	44	1	54
13	9	30	4	1	56	35	10	10	35	1	51
14	9	32	6	2	2	36	10	12	35	2	0
15	9	34	0	1	54	37	10	14	56	2	21
16	9	35	45	1	45	38	10	17	18	2	22
17	9	37	22	1	37	39	10	19	0	1	42
18	9	38	50	1	28	40	10	20	20	1	20
19	9	40	25	1	35	41	10	21	34	1	14
20	9	42	20	1	55	42	10	22	49	1	15
21	9	44	45	2	25	43	10	24	8	1	19
22	9	46	25	1	40	44	10	26	10	2	2

The train stopped at the Darlington station at 10h. 27m. 20s. It will be seen that the 43 miles were performed in 1 hour, 13 minutes and 53 seconds, or at the rate of nearly 35 miles per hour. The maximum speed (between the 5th and 6th mile-posts) was nearly 53 miles per hour, and the minimum rate rather more than 25 miles per hour. The average speed of the 80-tons train (exclusive of the engine and tender) upon the broad-gauge line was 47·5 miles per hour, and the maximum speed 55 miles per hour. There was, however, one thing greatly against the narrow-gauge experiment of this morning, viz.—the wind. When the train left the York station the weather was not at all unfavourable; the horizon promised rain, but very little wind was stirring. Up to the 10th mile-post the result promised to be pretty good; the last three miles had been done at about 52 miles per hour, and the narrow-gauge party calculated that the 43 miles would be got over in about 52 or 54 minutes. On reaching the 10th mile-post a heavy westerly wind came suddenly down upon the carriages, taking them obliquely in the direction the train was going. The effect was felt in less than a minute—the wind reduced the speed from 50 to nearly 30 miles per hour. There could be no doubt about the cause of retardation, because from the 10th mile-post the progress of the train was slow or fast in proportion to the length of embankment, open country or cutting. Immediately the engine entered a cutting, the increase of velocity was most sensibly apparent. If she entered a cutting of a couple of furlongs in length or 30 miles an hour, she dashed out of it at 38 or 40, and before another couple of furlongs had been run upon an embankment exposed to the gale the speed became reduced to 30 miles per hour.

The return trip commenced at 12h. 8m. 15s., and the train reached the first mile-post from the York station at 1h. 32m. 8s., performing the 43 miles in 1 hour, 24 minutes and 53 seconds, or at a speed of about 30 miles per hour. A stoppage took place in this trip for water, by which two or three minutes were lost.

The experiments were resumed on the following day.

The experiments yesterday with the 50 tons trains were considered so inconclusive, in consequence of the high wind which prevailed, that it was determined to repeat them to-day. The hour appointed for leaving the station was 9 o'clock. The train left at 9h. 2m. 10s., accompanied by Professor Barlow, Professor Airy, Mr. Watson, Mr. Brunel, Mr. Saunders, Mr. Gooch, Mr. Bidder, Mr. Wyndham Harding, Mr. Berkeley, Mr. Cabry, and about a dozen other gentlemen. The day was a favourable one. There was a slight breeze to the north, and the rails were in a fair condition. Contrary to the practice observed in the experimental trips on the Great Western Railway, the train did not stop at the first mile-post, and commence its experimental trip from a state of rest. Instead of doing this, it passed the post at the rate of about 8 miles per hour. The following is the working of the train for the 43 miles,—that is, measuring from the first mile-post out of the York station to the mile-post on the York side of the Darlington station:—

	h.	m.	s.	Time each mile in seconds.		h.	m.	s.	Time each mile in seconds.
Passed 1st mile-post at	9	6	30	—	Passed 23rd mile-post at	9	33	20	72
2	9	8	30	120	24	9	34	38	78
3	9	10	0	90	25	9	35	48	70
4	9	11	13	73	26	9	37	0	72
5	9	12	25	72	27	9	38	11	71
6	9	13	30	65	28	9	39	25	74
7	9	14	36	66	29	9	40	36	71
8	9	15	44	68	30	9	41	48	72
9	9	16	55	75	31	9	42	58	70
10	9	18	5	70	32	9	44	5	67
11	9	19	15	70	33	9	45	18	73
12	9	20	28	73	34	9	46	30	72
13	9	21	39	71	35	9	47	43	73
14	9	22	49	70	36	9	49	5	82
15	9	23	59	70	37	9	50	24	79
16	9	25	8	69	38	9	51	44	80
17	9	26	18	70	39 } 40 }	9	54	12	148
18	9	27	28	70					
19	9	28	38	70	41	9	55	30	78
20	9	29	48	70	42	9	56	48	78
21	9	30	59	71	43	9	58	10	82
22	9	32	8	69	44	6	59	58	108

The time occupied in performing the distance yesterday was 1 hour, 13 minutes, 53 seconds, or at the rate of something less than 35 miles per hour. It will be seen that to-day the same distance was accomplished in 53 minutes, 28 seconds, or at rather less than 48 miles per hour, the maximum speed, between the 5th and 6th mile-posts, being nearly 55 miles per hour. The wind of yesterday may therefore be considered to have offered a resistance equal to above 13 miles per hour.

The return train with the 50 tons left Darlington station at 11h. 21m. 0s., and passed the first mile-post at 11h. 22m. 18s. The following is the working of the engine:—

	h.	m.	s.	Time each mile in seconds.		h.	m.	s.	Time each mile in seconds.
Passed 1st mile-post at	11	22	18	—	Passed 23rd mile-post at	11	51	28	77
2	11	24	58	160	24	11	52	43	75
3	11	26	28	90	25	11	53	56	73
4	11	27	53	85	26	11	55	8	72
5	11	29	29	96	27	11	56	19	71
6	11	30	42	88	28	11	57	31	72
7	11	31	58	76	29	11	58	41	70
8	11	30	10	72	30	11	59	51	70
9	11	34	23	73	31	12	1	5	74
10	11	35	42	79	32	0	0	0	—
11	11	36	55	73	33	12	3	26	141
12	11	37	12	77	34	12	4	32	66
13	11	38	29	77	35	12	5	48	76
14	0	0	0	—	36	12	6	59	71
15	11	41	50	181	37	12	8	11	72
16	11	43	8	79	38	12	9	28	72
17	11	44	22	74	39	12	10	38	70
18	11	45	35	73	40	12	11	48	70
19	11	46	42	67	41	12	12	53	70
20	11	47	48	66	42	12	14	2	69
21	11	49	0	72	43	12	15	12	70
22	11	50	11	71	44	12	16	24	72

The next experimental trip was with an 80-tons train; and at a few minutes after 2 o'clock the train proceeded towards the first mile-post.

	h.	m.	s.	Time each mile in seconds.		h.	m.	s.	Time each mile in seconds.
Passed 1st mile-post at	2	19	38		passed 23rd mile-post at	2	39	0	76
2	2	11	48	130	24	2	40	18	78
3	2	13	18	90	25	2	41	40	82
4	2	14	34	76	26	2	43	0	80
5	2	15	52	78	27	2	44	20	80
6	2	17	11	79	28	2	45	34	74
7	2	18	25	74	29	2	46	50	76
8	2	29	40	75	30	2	48	14	84
9	2	20	52	72	31	2	49	32	78
10	2	22	5	73	32	2	50	50	78
11	2	23	18	73	33	2	52	8	78
12	2	24	30	72	34	2	53	25	77
13	2	25	48	78	35	2	54	42	77
14	2	27	8	80	36	2	56	0	78
15	2	28	26	78	37	2	57	28	88
16	2	39	40	74	38	2	59	0	92
17	2	30	54	74	39	3	0	30	90
18	2	32	12	78	40	3	1	55	85
19	2	33	34	82	41	3	3	18	83
20	2	35	0	86	42	3	4	42	84
21	2	36	22	82	43	3	6	06	84
22	2	37	44	82	44	3	8	8	[illegible]

From this table it is seen that with good weather to-day, the same engine upon the same line, and going over the same gradient (for curves there are none), took 80 tons 43 miles in 58 minutes, 30 seconds, or in 15 minutes, 23 seconds, less than she took 50 tons yesterday with a side wind against her.

THIRD DAY.—In consequence of an accident by the engine running off the rails, the experiments could not take place.

FOURTH DAY.—Two more experiments were made with the goods train of 200 and 400 tons respectively. The engine employed was the Hercules. She is a six-wheel coupled engine, with 4 feet 6 inches driving-wheels. Fire-box, 60 feet surface; tubes, 900 feet; cylinder, 15 inches; stroke, 24 inches; weight, 20 tons.

The engine started from the first mile-post beyond York at 9h. 36s., made seven stoppages, amounting to 40m. 50s., and arrived at the 43rd mile-post at 12h. 31m. 40s. The actual time of running, therefore, was 2h. 14m. 20s., or upwards of 18 miles per hour. The return trip from Darlington was with 400 tons, the train being above 300 yards long. The train left the 44¾ mile-post at 2h. 5m. 5s., and arrived at the first mile-post at 4h. 22m. 24s., without making any stoppages. This gives something like 19 miles per hour. The following is the working of the engine with the monster train, viz. 47 wagons.

	m.	s.		m.	s.
1st mile performed in..	4	6	24th mile performed in	3	1
2	2	20	25	2	50
3	2	10	26	2	50
4	3	30	27	3	10
5	6	20	28	2	59
6	3	40	29	2	30
7	2	20	30	2	40
8	2	10	31	2	40
9	2	10	32	2	35
10	2	20	33	2	35
11	2	40	34	2	50
12	3	20	35	4	0
13	3	0	36	5	10
14	3	0	37	7	20
15	2	40	38	6	30
16	2	20	39	3	30
17	2	10	40	3	30
18	2	10	41	3	0
19	2	4	42	3	0
21	2	30	43	3	0
22	3	25	44	3	20

It will be seen that the maximum speed was nearly 30 miles per hour.

THE LATE ACCIDENT UPON THE NORFOLK RAILWAY.

At an inquest commenced in December last, in consequence of a fatal accident on the Norfolk Railway, considerable interest was excited on account of the contradictory opinions expressed by two gentlemen of the highest eminence for their knowledge of engineering—General Pasley and Mr. Bidder. General Pasley did not hesitate to assert in his evidence that Mr. Bidder had, in the course of his examination, expressed opinions "quite erroneous and *contrary to the first principles of mechanics.* It is of the highest importance to the engineering profession to ascertain the truth respecting several very important views propounded during the inquest.

It does not lie within our plan to give a detailed account of the accident, it will be sufficient for our purpose to state simply that it arose from the engine running off the rails. The following extracts from the evidence of Mr. Bidder embody the notions which General Pasley declared to be contrary to sound philosophy.

"The inclination of the line where the engine had run off was 1 in 100. The permanent way was as good a piece as any in England. It was constructed on a chalk embankment, the most favourable soil for such work. At the point where the engine left the rail the embankment was raised about five feet above the ordinary surface of the earth. The chalk in the embankment was used in large lumps, and he thought the late wet weather would have no effect upon it. On examining the engine he found the steam-regulator indicated that *the steam had been turned off suddenly*, the effect of which would be precisely similar to that which had been described by the previous witness. The speed of the engine would be more retarded than the carriages, and the train would urge the engine on, forcing it off one side of the rail, and the carriages on the other. He attributed the accident to the impropriety of the engine-driver *proceeding at a very high velocity and suddenly shutting off the steam.* Moreover, the line near Thetford being under repair, it required particular caution in passing over it, and if the deceased did not exercise that precaution, it showed a great want of care on his part. He had no means of judging the exact speed the engine was going, but his opinion was, that it must have been *very great, far beyond that of the proper speed*, viz., 30 miles an hour."

The evidence of the next witness examined after Mr. Bidder is important, not for matters of opinion but matters of fact; for it appears that he distinctly stated the circumstances on which Mr. Bidder founded his opinion to be, in reality, quite different from those under which the accident took place. Coleman, the chief guard of the train says, that "no alteration was made in the speed more than usual," that the speed of the train "up to the period of the accident *did not exceed 35 miles an hour,*" and that "he had travelled on the line frequently as fast as he did on Wednesday." He says also that just before the accident, the engine gave a "tremendous jump;" that he could see distinctly what the engine-driver was doing, and that "the moment the engine jumped, Pickering turned round and looked on one side, and *then* cut off the steam." He swore positively that "Pickering *did not* shut off the steam *until after the engine had jumped off the rails.*"

The evidence of Major-General Pasley is as follows.

General Pasley—My opinion is, that owing to the peculiar construction of the engines, like the one that met with the accident on the Norfolk line, they are not the most suitable to the narrow gauge, as they do not admit of any great speed without danger. They are perfectly secure on the narrow gauge at a certain rate. For instance, the distance from the Harsling-road station to Thetford is eight miles, and 26 minutes is allowed to accomplish that distance. The distance and time noted in the Norfolk Railway Company's time-bill can be travelled over without any excessive speed. If by any extraordinary neglect 10 minutes should be lost between those two stations, there is 16 minutes to go the eight miles, a rate of 30 miles per hour.

Coroner—Can you account for the broken chair, which was 22 feet from the sleeper, that was cut apparently by the engine when it got off the rail?

General Pasley—I should say that the chair was broken by the motion of the engine. If it was defective before, the motion might contribute to its breaking entirely.

Coroner—What description of engine was it that met with the accident?

General Pasley—One of most extraordinary length of such a length as was never used on the narrow or any other gauge before. If you will allow me, I will mention a circumstance respecting these peculiar class of engines. Some months ago there existed doubts as to the safety of express trains to travel by, and knowing that oscillation of carriages was no proof of danger, or that their steadiness ensured perfect safety I determined to ride upon the engines, with a view of more easily detecting their unsteadiness—their oscillating indicating danger. I travelled lines in different parts of the country, and the only engine I found having such an oscillation was one on the South Eastern Railway, called the White Horse of Kent, manufactured by Mr. Robert Stephenson, and of the same peculiar construction as the one that went off the rails on the Norfolk line. I went on that engine at the rate of 44 or 45 miles an hour, and at that speed she rolled something like a ship at sea. The oscillation, when the train is going at such a rate, indicates a danger of running off the rail. I told the engine-drivers and other authorities that if they ran 50 miles an hour, like the express trains on the Great Western Railway, the greater likelihood of the engines rolling over. I have stated that opinion to the Gauge Commissioners. The difference between the engine you have alluded to as manufactured by Mr. Robert Stephenson and those employed on the Great Western, is thus—The narrow gauge not offering so great a diameter of boiler as the broad, Mr. Stephenson, to remove the obstacle, constructed the long-boiler engines to equal them in power, and they have failed in the purpose for which they were intended. The long boiler engines, which Mr. Stephenson persevered in, are four or five feet longer than those of original construction, the smoke box overhangs the fore wheels, and the fire-box and dome the hind wheels, which will cause them to oscillate. I think such an engine as the one in question can go at 30 or 35 miles an hour, and I think I have gone at 45 miles an hour upon them; but when they approach 50 I think they are unsafe, and that is an opinion not hastily formed. I have mentioned it frequently to engineers and superintendents of railways, as well as to the Gauge Commissioners. The Great Western Railway has been worked by engines of one pattern for the last five or six years. The motive for forming the long-boiler engine was to gain a larger evaporating surface, and thereby obtaining greater power of steam. That however has failed, owing to the tube at the fore part of the boiler being so far distant from the fire-box, and not being exposed to the full action of the heat. The engine on the South Western, Manchester and Birmingham, and Grand Junction Railways, of the make of Messrs. Sharp and Brothers, with boilers of moderate length, have equal, if not more power, and are capable of going at any speed they will admit of, providing the ground is in good order. I think these long boiler engines, if they are going at a rate exceeding 40 miles per hour, are liable to oscillate and run over the line. The cause is the defect in their formation. It is the wheels huddled together, or the axles under the boiler, that gives so much overhanging dead weight at each end, which I have not found with any other engines but those of Mr. Stephenson.

Coroner—Did you ever anticipate an engine of this description meeting with such an accident?

General Pasley—The fact is, I did not expect such an accident could have taken place. I did not think that such an engine could have gone at the speed it did in running off the line. It is a rule with engine drivers to shut off the steam on a descending gradient, and in all my journeys in railway travelling I never found them neglect doing so. I have frequently informed the engine-drivers of these engines of the danger they were incurring when driving them at a rate verging upon 50 miles per hour. In the north of England, however, I remember being on one of Mr. Stephenson's long-boiler engines, and two pair of the wheels were coupled together, and in riding upon it I felt more secure than I would upon the two other ones, as the coupling produces steadiness, and consequently safety. I wish to explain why I consider that the sudden shutting off of the steam could not have led to the accident—the grounds upon which I differ with other opinions. When the steam is shut off suddenly, more especially on a descending gradient, the momentum will drag the tender and carriages for a considerable distance, and presuming that the engine should become detached from the tender, its impetus would carry it far in advance; so much so, that the train would fail in overtaking it. The engine would proceed faster than the carriages. In order to show you the effect of suddenly shutting off the steam, I was lately on an engine on the Bristol and Gloucester Railway with Mr. Connell, the locomotive superintendent, the Gauge Commissioners being in the train, when I desired a greater speed to be put on, and then requested the steam to be turned off suddenly. It was done so, and not the slightest effect was produced. Again, on the Great Western Railway I was on an engine with Mr. Brunel—two tenders attached and a goods'-train of 2,000 tons, with a speed of 30 miles an hour. I desired Mr. Brunel, when they had to stop at a station, to shut off the steam suddenly a minute before the breaks were applied. It was done frequently, and not the least effect felt. The tender did not crowd upon the engine, and neither did the wagons crowd upon the tender. In short, shutting off the steam produces no effect, unless the breaks are applied, more especially in descending an incline of 1 in 200. At the New Cross incline, which is 1 in 100, the trains are always stopped by turning the steam off suddenly, and applying the breaks immediately, and if the cause of the accident was really the shutting off the steam, accidents would be constantly occurring at New Cross. Whenever there was a necessity for such a step I should have no hesitation in adopting it.

Coroner—Then, Sir, you quite disagree with Mr. Bidder's opinion as to the cause of the accident?

General Pasley—I consider Mr. Bidder's opinion perfectly erroneous; at the same time I wish to observe that Mr. Bidder is a gentleman of much ability, but in this case I think he is much mistaken; his opinion is contrary to the first principle of mechanics. The dimensions of the engine are 19 ft. 6 in. in length, without the foot-plates which the engine-driver and occasionally the stoker stand upon, which gives about 2 feet more. The distance from the centre of the front and hind wheels is 10 ft. 3 in., so that the smoke-box is projecting before the fore wheels, and the fire-box and dome overhanging the hind wheels. In all engines, before Mr. Stephenson took out his patent for the construction of the long-boiler engines, the hind wheels are in the rear of the fire-box and dome, and consequently there is no overhanging dead weight at the rear of the wheels. When I first saw the engines I thought them very good in travelling at a moderate rate, but I now see no advantage in their construction or improvement. The fore part of the boiler being so far from the fire-box, the tubes being so much distant, the engines do not afford the power that was expected from them. The engines of Sharp, Brothers, and Co., with moderate length boiler, possess equal or greater power, and are free from danger.

Coroner—Are there any signal posts to denote gradients.

General Pasley—After the first accident on the Eastern Counties Railway, the Earl of Dalhousie wrote to the board desiring that all the inclines should be marked out with posts, which had been done to guide engine-drivers; for at the accident at Littlebury, on that line, the superintendent of the locomotive department, who was on the engine, and the driver, were really descending a gradient without knowing it.

Coroner—Mr. Bidder has told us that on gradients of 1 in 200, engines are in the habit of travelling at the greatest velocity?

General Pasley—Then that is contrary to my general experience. I never travelled an incline but that the steam had been partially or perfectly shut off. It is a general rule to shut it off on going down an incline. I do not think that on a gradient of 1 in 200, engines are in the habit of running at the greatest possible velocity.

Coroner—Then we perfectly understand you to say, that shutting off steam in descending a gradient would not cause an engine to stop?

General Pasley—Certainly, if the breaks were not applied. If the decline is 20 miles in length, it will not stop until it comes to a level. It is the source of gravity. Its momentum forces it along.

The learned Coroner proceeded to sum up the evidence, and after commenting on the principal facts as related to the unfortunate occurrence, remarked upon the wide contrast of opinion entertained by Major-General Pasley and Mr. Bidder. It was for the jury to determine, knowing well that they would so decide as would ensure the public every safety.

The verdict was "Accidental death, caused by the imprudent conduct of the engine-driver in going at an excessive speed."

General Pasley, on his return to town by the last train, rode on the engine of the Eastern Counties Company, one of the same description as those that ran off the rails at Littlebury and Waterbeach, built by Stothart, Slaughter, and Co., in order to test its capabilities. The speed on one portion of the line between Bishop's Stortford and Stratford was for a short time upwards of 45 miles an hour, and the engine rode very steady; and in two or three instances, on nearing a station, he directed the engine-driver to turn the steam off suddenly, full a minute before the breaks were put down, and not the slightest effect was produced.

The reply of Mr. Bidder appears in the form of an advertisement, published in the *Times*, from which we make the following extracts:—

"The substance of the evidence which I gave was to the effect, that by the sudden shutting off of the steam of the engine, the carriages were no longer drawn by the engine, but that the engine was propelled by the carriages, and that this, in combination with other circumstances which (as I then stated) might not occur once in a thousand times, had, on this occasion, the effect of forcing the engine off the line.

"The grounds upon which I formed this opinion are based upon what I must still believe to be a well-established law of mechanics—viz., that in any system of bodies moving together, if there be no resistance, or if the resistance of each body be in the like ratio to its weight, when the motive power ceases to act upon them, these bodies will exert no influence upon each other in any direction, but if the resistance to the motion of the bodies in front be greater than that which is required to sustain the motion of those which are behind, the retardation of the former will be more rapid than that of the latter, and will be impelled by them, and *vice versâ*.

"Applying this to the case of a railway train in motion, we have this fact for our guidance—that an engine requires from 7 to 12 lb. per ton more to sustain its motion than the carriages—it must inevitably follow, that the effect of suddenly shutting off the steam causes the carriages to overtake and impel the engine forward, as stated by me in my evidence."

It certainly must be conceded that assuming with Mr. Bidder, the resistance to motion to be 7 to 12 lb. per ton more for an engine than for carriages, the carriages will exert a pressure against the engine when the steam is suddenly cut off. But the misapprehension on which General Pasley grounded his censure of Mr. Bidder appears to be this—that he presumed Mr. Bidder's notion to be that the carriages acted on the engine not by a continuous pressure, but by impact or collision. There is no ground however for supposing that Mr. Bidder entertained this idea. At the same time while defending him from the charge of having erred in the first principles of mechanics, we do not hesitate to deny the possibility of the accident having arisen from the causes assigned by him.

It appears from the very careful and elaborate experiments of M. de Pambour, that the friction of an engine when not drawing a train (the case here supposed) is about 14 lb. per ton. The friction of carriages is 6 lb. per ton. This gives an excess of 8 lb. per ton for the friction of the engine. But from this must be deducted the resistance of the air, a most important item in considering high velocities. The resistance of air on the carriages is much greater than on the engine in proportion to the weight of each. We should be quite safe in supposing that at velocities ranging from 30 to 50 miles an hour, the resistance from this cause is 3 or 4 lb. greater per ton on the carriages than on the engine. So that on the whole we may safely conclude that when the engine and train are disconnected at a high velocity, the steam being cut off at the same time, the excess of resistance on the engine is certainly not more than 5 lb. per ton.

Now we shall have no difficulty whatever in showing that the pressure which the carriages will exert on the engine under these circumstances is no greater than that which could be easily exerted by a boy 12 or 14 years old. By the very simplest mathematics it may be demonstrated that the pressure is equal to 5 times the *product* of the number of tons which the train and engine weigh respectively, divided by the *sum* of those numbers.* For instance if we suppose the weight of the train 40, and of the engine 10 tons, the product of those two numbers (400) being divided by their sum (50) gives 8, which multiplied by 5 gives 40 lb for the pressure on the engine. Again, take the weight of the train at 60 tons, and of the engine at 12 tons, 12×60 is 720 and $12 + 60$ is 72: dividing 720 by 72, and then multiplying by 5 as before, we get 50 lb. for the pressure on the engine.

It must be carefully noted that the pressure here calculated represents the *whole* effect of the train on the engine. There is nothing like impact or collision because the velocities of both engine and carriages are initially the same, and are *gradually* retarded.

Now it would be perfectly ludicrous to imagine that a pressure of 40 or 50 lb. would injure an engine or force it off the line. Taking the weight which a man can usually raise at 200 lb. (no very high estimate) we have for the pressure in question one-fifth to one-fourth of the average of human strength. Even if we take Mr. Bidder's own account and assume the excess of resistance to the engine over that to the train at 7 to 12 lb. per ton, the case is made very little better, for even then the pressure is not nearly so great as that which could be exerted by one man.

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* Let M be the number of tons which the train weighs, F the resistance per ton to it, P the mutual pressure between the train and engine: then measuring the accelerating force from the time of disconnecting the two, in the direction of motion, we have

$$M\frac{d^2 x}{dt^2} = -MF - P$$

for the motion of the carriages. For the motion of the engine we have, putting M' for the number of tons, and F' for resistance per ton,

$$M'\frac{d^2 x}{dt^2} = -M'F' + P$$

P here changing its sign. Equating the values of the differential (which we may clearly do since the carriages and engine are supposed to continue moving at the same velocity) we get the pressure P equal to

$$\frac{MM'}{M+M'}(F'-F).$$

So that if we leave mere generalities and come to actual calculation, the whole theory seems fallacious enough. What is the pressure in the case in question compared with that which the carriages and engines exert on each other when the engine has to be reversed to move carriages backward? And this occurs daily and hourly without any very disastrous consequences.

A much more serious source of accidents on the Norfolk Railway appears to us to be the manner in which the tranverse sleepers are laid. Being made from unsquared timber sawn in half lengthways, their form is hemi-cylindrical. Now these half cylinders are not (we understand) laid with their flat sides downwards, as in many other railways where they are of course firmly supported by the soil: but in the Norfolk Railway the sleepers are laid with the flat sides uppermost. The hold which the *rounded* sides have on the soil is comparatively small, and it is obvious that a pressure on one side of the upper side of the sleeper might easily cause it to slip round. If for instance, a stone resting on the edge of the sleeper were pressed upon it by the passing of the train, it would certainly tend to shift the position of the sleeper, and therefore of the rails.

Mr. Robert Stephenson's Report.

The following report upon the causes of this deplorable occurrence has been presented by Mr. Robert Stephenson to the directors:—

To the Directors of the Norfolk Railway.

Gentlemen,—Absence from London on urgent business has prevented me complying earlier with your request that I should report to you my observations on the statements made in the evidence given at the inquest on the late accident upon the Norfolk Railway.

I returned to town last night, and now proceed to lay before you such remarks as have suggested themselves. In the outset I may state, that I concur generally with the engineering evidence given by Mr. Bidder and Mr. Marshall. I shall therefore confine my observations to the evidence of General Pasley, but before I direct your attention to the individual statements, I must observe, that I have experienced considerable difficulty in dealing with them, in consequence of their being merely expressions of opinion, without adducing arguments or specific facts to support them. If the General had, after giving an opinion, stated the particular reasons or result of calculations which led him to such conclusions, then their validity might have been tested. In the present instance such a course is doubly necessary, because the subject, from the tone assumed, is made not merely a scientific one, but one involving professional character. I shall, however, confine my remarks to the former.

General Pasley commences by stating that the description of engine was one of "extraordinary length, of such a length as was never used on the narrow or any other gauge."

From this statement everybody would conclude that this class of engine was not in very general use; that little or no experience had been obtained of its peculiarities; that it was an experimental engine, possessing several obvious defects.

Against this assumption I only think it necessary to state the fact that upwards of 150 engines of this description have been in daily use in this country and on the continent for the last two or three years; that the long boiler has, by every experienced and impartial locomotive manager with whom I have communicated, been received as a decided improvement; so much so, that since this class of engine was first introduced, the boilers of old engines have been, in several cases within my own knowledge, very considerably lengthened; thus offering the most incontestable proof that the old construction of engine is admitted to be deficient in length of boiler. You will bear in mind that I am now speaking of the boiler simply; the other parts of the construction of the engine upon which General Pasley offers an opinion I shall come to afterwards. I need hardly say, that during the working of such a number of engines over such a length of time, it is impossible to conceive the avoidance of accident. If this construction of engine involved danger to the extent stated by General Pasley: but, as if to meet this argument, the General in his evidence qualifies his opinion of danger by saying, "that such an engine as the one in question can go at 30 or 35 miles an hour, and I think I have gone 45 miles upon them."

I can only state my own experience leads me to a different conclusion, and that I have frequently been upon this description of engine when the speed far exceeded those above referred to without the slightest accident occurring.

Oscillation in the body of the engine at high velocities I regard as inevitable, no matter what the construction may be; but this oscillation arises from causes which cannot have come within the Inspector-General's sphere of observation. It is only the practical man whose opinion on such points can be depended upon; it is not the occasional riding upon an engine that can enable any one to decide between the construction of one class and another, or to decide that dangerous oscillation is caused by an overhanging firebox or a long boiler. In a word, to decide a point of this kind it is absolutely essential to examine the condition of the engine as well as its construction; for instance, the steadiness of all six-wheeled engines essentially depends upon three conditions,—

1. The distribution of the weight upon the three axles.
2. The lateral play in the bearings.
3. The distance between the extreme axles, that is, the extreme length of bearing upon the rails.

Of these the last only is permanent; the two first are constantly subject to change. An engine which is perfectly safe and comparatively steady to-day may become unsteady, and even dangerous at high speeds, in a short time by an alteration either in the springs or by the lateral wearing of the bearings. Now, I have reason to know that the White Horse of Kent, the only engine which General Pasley quotes as having oscillated excessively, although he has tried several others, was not in the best working condition at the time he made the experiment; no opinion with reference to its motion could therefore with propriety be drawn without taking into account the condition in which the bearings were at the time, together with the disposition of weight upon the wheels.

All engines when allowed to get play upon the bearings become unsteady at high velocities, and oscillation from this source is aggravated if more than a due proportion of weight be thrown upon the middle pair of wheels.

I believe nearly all the accidents which have occurred by engines leaving the rails are mainly attributable to want of attention to this condition.

In bad weather, when the rails are slippery, the temptation to the engineman to increase the weight upon the driving wheels is very great, and I have frequently known it carried to an improper extent. How far this may have operated in the Norfolk Railway accident cannot now be ascertained, but, referring to that which took place during the progress of the experiments on the Great North of England Railway, under the Gauge Commission, I have ascertained that this improper distribution of weight was one of the chief causes of the engine leaving the rails. On a piece of absolutely perfect road this cause would in all probability not have produced the result, but in cases of this kind the ultimate result seldom, very seldom indeed, flows from one cause; it is the concurrence of two or more circumstances operating in the same direction.

If accidents on railways arose from any peculiarities of construction in the engine, we ought to have them every day. If the overhanging firebox so much objected to by General Pasley were dangerous, it would be absolutely impossible to work the London and Birmingham one day without a series of accidents. The engines upon that line have fireboxes projecting beyond the bearing axle fully 4 feet 6 inches, being 5 inches more than the corresponding projection of the Norfolk engine. The London and Birmingham line has been worked now nearly eight years with an unparalleled traffic with engines having overhanging fireboxes, without any accident which can fairly be attributed to such a peculiarity of construction.

I originally objected to this projection of the firebox beyond the axle; but, after an experiment continued uninterruptedly for a series of years, with an enormous traffic, it would be absurd to reject such practical evidence and to hold to such an opinion.

It was this opinion that led me to the construction of the new long-boiler engine, and the abandonment of the objection I originally entertained and acted upon. When I considered, moreover, that the London and Birmingham engines had, in addition to the overhanging firebox, a remarkably short bearing upon the rail, and, consequently, admitting of the overhanging weight operating with increased effect, the testimony appeared to me conclusive.

The London and Birmingham engines in the commencement had a bearing upon the rail of only 5½ feet (they have since been extended), whereas the Norfolk engines have a bearing of 10½ feet. On this point I need not confine my reference to the engines upon the London and Birmingham, because they are not peculiar to that line; they are to be found on many others.

Whatever may be the effect of such evidence upon the minds of others, I must confess that to me it appears perfectly conclusive that the overhanging box exercised no influence such as General Pasley imagines.

In confirmation of this, I may state that yesterday, with a passenger train of 40 tons, with a boisterous side wind, I came from Darlington to York on the A engine, which has an overhanging box and long boiler, accompanied by Mr. T. E. Harrison, Mr. Fletcher, and Mr. Joseph Stephenson, for the express purpose of trying the oscillation of the engine. For several miles the speed exceeded 58 miles an hour, and in some we passed the consecutive quarter mile posts in 15 seconds, being 60 miles an hour. In addition to the overhanging firebox, we were all standing on the footplate with the engineman, excepting Mr. Joseph Stephenson; consequently, the circumstances were peculiarly calculated to excite oscillation, if the tendency existed to any appreciable extent. I am, however, enabled to declare most positively, that this engine was not only entirely free from any dangerous oscillation, but as steady as any engine I ever rode upon. Here I will leave the question of overhanging firebox and proceed to notice the next peculiarity of the Norfolk engine specially noticed by General Pasley—viz., "The wheels being huddled together."

In looking at this part of the subject, I am relieved from any discussion as to matters of opinion; it is simply one of dimension, which admits happily of no dispute. I therefore give you the dimension of Slaughter's engine, which the General returned to town upon, and declared safe and steady, and those of the Norfolk engine, which he condemns:—

	Ft.	In.
Slaughter's engine, distance between extreme axles ..	11	0
Norfolk engine, distance between extreme axles ..	10	6

I leave the General to say whether this difference of six inches justifies the epithet, "huddled together," as applied by him to the wheels of the Norfolk engine.

The General, in another part of his evidence, says, "These engines (alluding to Slaughter's), although they are of a long boiler construction, have no overhanging weight like Mr. Stephenson's." This, like the last, is merely a question of dimension, the fact being that at the chimney end Slaughter's engine overhangs precisely to the same extent as the Norfolk engine—viz., 4 feet 9 inches; at the firebox end in Slaughter's engine the axle is placed underneath the middle of the firebox, whereas in the others it is placed immediately in front of it, without, however, giving the engine more than 6 inches additional base upon the railway, and this in a distance of 11 feet; yet this shade of difference, according to the General, makes the one engine safe and steady, and the other dangerous, and apt to "roll like a vessel at sea," and this without reference to the fact that the centre of gravity of the Norfolk engine is fully a foot lower than Slaughter's. Were it necessary to adduce any further evidence it would only be necessary to recall to mind the base of the London and Birmingham engines, where, with an overhanging firebox, the base of the rail does not exceed 7 feet.

I do not think that comment on such a conclusion is necessary: if a shade of difference of this kind be really adequate to produce such consequences as are here stated by the Inspector-General, the sooner the construction of every class of locomotive engine is revised the better.

General Pasley states in another part of his evidence, that "the narrow gauge not offering so great a diameter of boiler as the broad, Mr. Stephenson, to remove the obstacle, constructed the long boiler engines, to equal them in power, and they have failed in the purpose for which they were intended." And again, "that owing to the fore part of the boilers being so far from the firebox, the tubes being so much distant, the engines do not afford the power that was expected from them."

This paragraph I have no hesitation in declaring to be entirely erroneous. In the first place, the motive for lengthening the boiler had no reference to gauge at all, because it is equally applicable to all gauges; the object was to save fuel, by preventing the escape of a large quantity of waste heat up the chimney; in this it has been perfectly successful, which has been established by every experiment tried with this object. Even with the longest tube yet introduced in locomotive engines, the temperature at the chimney end has been found sufficient to melt lead, which is upwards of 200 degrees above the temperature of the water in the boiler. The opinion of General Pasley on this point is equally at variance with the most extensive experience with stationary engine boilers, which are much longer, with much less velocity of draught.

It must be obvious to every one that every addition to the economy of fuel obtained by an enlarged evaporatory capacity is necessarily attended with a corresponding increase of power, and therefore, as before observed, although my original object in lengthening the boiler was with the view of economical results, it has been attended with a large increase of power. I beg therefore to remove the impression produced by General Pasley's evidence, by emphatically declaring that the long boiler arrangement suggested itself to my mind, indeed was in actual operation, years before the question of gauges was agitated. I forbear here going into the question of gauge, which has been so pointedly introduced by General Pasley both in his evidence and in his letter in *The Times*, because it is both foreign to the subject, and can lead to no result whilst it is under the consideration of the commission appointed for that purpose.

In conclusion, I am willing to believe, nay, I am sincerely convinced, that General Pasley, in giving his evidence, was actuated by no other motive than a wish to arrive at the truth, but in the present instance I must be excused for regarding him as having ventured to give opinions upon a difficult subject, and one with which neither his education nor experience can have made him thoroughly acquainted. In venturing thus to express myself, I am far from wishing to imply the least disrespectful feeling to General Pasley; on the contrary, my experience in the mode in which he has filled the difficult office of Inspector-General has led me to respect him, and at all times to aid him by giving him opinions on practical subjects whenever an opportunity presented itself; but in the present case I am so personally involved by his evidence, and feel so strongly convinced that his views are entirely erroneous, and calculated to injure railway interests, that to express my opinion with any reservation would be injustice to many railway companies whose confidence I enjoy.

I am, Gentlemen, your obedient servant,
Robert Stephenson.

24, Great George-street, Westminster, Jan. 21.

FALL OF A VIADUCT ON THE ROUEN AND HAVRE RAILWAY.

(*Extract from a Private Letter.*)

It being possible that the news of the falling of the whole of the viaduct of Barentin, on the line of the projected railroad between Rouen and Havre, and within three leagues of the former place, may not yet have reached you, I therefore hasten to send you all the particulars that I have collected.

This event took place on Saturday last, the 10th January, and has made a deep impression on the feeling and fears of the population of Havre, who looked forward with much anxiety to the speedy and safe accomplishment of an undertaking in which their commercial and general interests are so importantly involved. Now that the accident has happened, opinions, which were formerly kept in subjection, are expressed without reserve, and it would appear that doubts have long been entertained of the solidity of the works, of the amount of care observed, and of the quality of the materials used in the construction of this railroad. One shudders at the idea of the dreadful consequences which might have ensued had the road been in full operation at the time of the accident. The fall of this enormous work, raised to the height of 32 yards French, (about 105 English feet) above the soil, naturally gives rise to the most serious apprehensions for the eventual fate of two others, those of Malanney and Mirville, which the same conditions expose to a like result.

Public confidence in the general stability of the works upon this railroad has, by this dreadful event, received a blow, the effects of which can only be removed by the test of time and a long series of successful operations. Happily, no lives have been lost, nor much property in the immediate vicinity destroyed by the fall of the viaduct. A flourmill, situate upon the river St. Austreberthe, was entirely knocked down, and it was not till within an hour afterwards that the inhabitants of Barentin could make their way across the masses which eucumbered the road to the rescue of the sole inmate, who miraculously escaped with a slight wound only of the finger. The machinery and fragments of the mill were scattered about in every direction.

The *Journal des Debats* publishes the following letter on the subject of the late catastrophe which occurred on the Rouen and Havre Railroad:—"I have the honour to address you the following note, with a request that you will insert it in your next number. The directors of the Rouen and Havre Railroad Company hasten to publish the first information transmitted to them on the state of the viaduct of Berentin by Mr. Locke, the principal engineer of the company. The directors have since had a conference with the principal engineer, at which the announcement made in the journals of last evening was fully confirmed—viz., that the cost of the rebuilding of the viaduct of Barentin will be at the expense of the contractors, and that the reconstruction of the viaduct will not retard for more than two months the opening of the line. The plan of the reconstruction was this day arranged by the board of directors, and will be presented to-morrow to the Minister of Public Works. The damage caused to the proprietors in the neighbourhood of the viaduct is of no serious importance, and can give rise but to a slight indemnity, already partly arranged.—E. Delacour, Secretary to the Company."

THE JANUS STEAM SHIP.

(Wecopy the following article, addressed to the Editor, from the *Times*.)

Sir—The frequent articles inserted in your universally circulated paper relative to the Janus, indicate that the success or failure of the engines, boilers, and lines of construction are subjects of public interest.

Being thus confirmed in my opinion, I enclose to you the last report made on the original revolving engine erected by the late Admiralty in Portsmouth Dockyard, the performance of which engines gave to the present board the confidence they have manifested in promoting the attainment of an object highly interesting to the naval service.

Those only who attempt to introduce an important novelty can estimate the effects of jealousy and prejudice. I confide, however, in your liberality to aid in their removal, and beg that you will inquire whether any reciprocating engine has ever performed duty equivalent to 13 consecutive double voyages from England to America (as the Portsmouth engine has done), almost without repair?

I am, Sir, your obedient servant,
Dundonald.

Portsmouth, Jan. 8.

Report of the Earl of Dundonald's Rotatory Engine erected in Her Majesty's Dockyard at Portsmouth.

On the 22d of December, 1845, two years and nine months of constant performance of the rotatory engine expires, during all which time it has been working in the most effectual and satisfactory manner, no derangement of consequence having ever taken place.

It is presumed that these two years and nine months of constant and laborious operation (requiring no more than slight attention by the workmen) have gone far to establish that quality which, until now, had not been sufficiently developed,—namely, durability, and consequent continuity of operation.

The principal repair this engine has required was taken in hand about nine months ago. This was so trifling that six men could have accomplished it in one day, but having been much pressed with work at the time, one man only could be spared, which consequently protracted its completion for one week.

Thus after four years and nine months constant working as a prime mover, two years and nine months of which have been so successfully performed, nothing more can be wanting even by the most sceptical to establish its merits as a powerful, economical, and durable engine, equal in point of efficiency to any reciprocating engine in Her Majesty's service.

Should additional evidence be sought to establish further claims as a rival in steam mechanism, it is to be found in the simple fact, that this first essay on the Earl of Dundonald's principle, although at first altered and mutilated to bring it to perfection, is nevertheless at the present time perfectly free from those indications of weakness and declining energy which any other engine, under similar circumstances, might probably evince, as is proved by its exhibiting a vacuum at all times equal to 28 inches of mercury.

Another fact which gives great confidence in the utility and applicability of this principle is its freedom from liability to internal derangement, and consequently the service in which it is engaged is scarcely ever inconvenienced by stoppages.

The engine has not been opened for examination since July last.

R. Taplin, Engineer and Machinist.

Her Majesty's Dockyard, Portsmouth, Dec. 31, 1845.

ARTIFICIAL ULTRAMARINE.

Till within the last twelve or fifteen years the only source of this beautiful pigment was the rare mineral, *lapis lazuli*. The price of the finest ultramarine was then as high as five guineas the ounce. Since the mode of making it artificially has been discovered, however, its price has fallen to a few shillings the ounce. Artificial ultramarine is now manufactured to a very considerable extent on the continent, but, as far as I can learn, none has as yet been made in Great Britain. The chief French manufactories of ultramarine are situated in Paris; and the two largest ones in Germany are those of Meissen in Saxony, and of Nuremberg in Franconia. Three kinds of ultramarine occur in commerce, the blue, the green, and the yellow. The two first only are true ultramarines, that is sulphur compounds; the yellow is merely chromate of baryta. Both native and artificial ultramarine have been examined very carefully by several eminent chemists, who, however, have been unable to throw much light upon their true nature. Chemists have undoubtedly ascertained that ultramarine always consists of silica, alumina, soda, sulphur, and a little oxide of iron, but no two specimens, either of the native or artificial ultramarine, contain these ingredients in at all similar proportions. . . The last chemist who has examined ultramarine is Dr. Elsner, who has published a very elaborate paper upon it in the 23rd number of Erdmann's Journal for 1841. The first part of Dr. Elsner's paper is historical, and contains an account of the accidental discovery of artificial ultramarine by Tassart and Kulhman in 1814, and of the labours of subsequent chemists. He then gives a detailed account of his own experiments. . . Dr. Elsner's paper does not, however, furnish any details by which ultramarine could be manufactured successfully on the great scale. Thus, for example, in regard to the necessary degree of heat, perhaps the most important circumstance in the process, he gives no directions whatever. We know, however, from other sources, that it should be a low red heat, as at much higher temperatures both native and artificial ultramarine soon become colourless. Dr. Elsner, indeed, does not affirm that he was able to procure ultramarine in quantity of a uniformly good colour. In fact, the process of Robiquet, published nearly ten years ago, is the best which scientific chemists possess, though undoubtedly the manufacturers have greatly improved upon it. Robiquet's process consists in heating to low redness a mixture of one part porcelain clay, one and a half sulphur, and one and a half parts anhydrous carbonate of soda, either in an earthenware retort or covered crucible, so long as vapours are given off. When opened, the crucible usually contains a spongy mass of a deep blue colour, containing more or less ultramarine mixed with the excess of sulphur employed, and some unaltered clay and soda. The soluble matter is removed by washing, and the ultramarine separated from the other impurities by levigation. It is to be regretted, however, that the results of Robiquet's process are by no means uniform; one time it yields a good deal of ultramarine of excellent quality, and perhaps, at the very next repetition of the process in circumstances apparently similar, very little ultramarine is obtained, and that of an inferior quality. The fabrication of ultramarine is a subject which well deserves the attention of English chemical manufacturers, as it could be carried on with peculiar advantage in this country. The chief expense of the process is the fuel required, which can be purchased in Great Britain for less than half the money it would cost either in France or Germany.—*Proceedings of the Glasgow Philosophical Society.*

The Nelson Monument.—The completion of this work has at length been determined on by the Woods and Forests, and to this effect a communication has been made to the artists to whom the commissions have been confided, by the Earl of Lincoln. The subjects proposed for the four bassi relievi are the victories of Cape St. Vincent, Copenhagen, the Nile, and Trafalgar; and the sculptors appointed to execute these works are Mr. Watson, Mr. Woodington, Mr. Carew, and Mr. Turnouth. The four lions will be executed by Mr. Lough. The relieved works will be in bronze—the lions in stone or granite.—"Examiner."

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL SCOTTISH SOCIETY OF ARTS.

Monday Jan. 12. Sir Geo. S. Mackenzie, Bart., of Coul, F.R.S.E., President, in the Chair.

The following communications were made:

1. "*A Development of the operation of the Harmonic Ratios in a progressive series of Scalene Triangles, and of their effect upon the Rectangles which these Triangles produce, by the union of their hypothenuses; with Remarks upon the utility of such a series in an Æsthetical point of view.* By D. R. Hay, Esq.—Mr. Hay, in reading this paper on the harmonic ratios, exhibited by drawings, made in presence of the meeting, their operation, by a natural process, in producing a series of scalene triangles having all the harmonic properties in relation to *form*, that the natural diatonic scale of music has to *sound*. He showed that the beauty of proportion and symmetry depends upon the operation of the numbers 2, 3, and 5, and that these numbers operate in the formation of geometrical figures by the division of the circle into 360 degrees; asserting that no other mode of division would produce the same results, because that number is in a peculiar manner (which he also exhibited to the meeting) a multiple of those three harmonic numbers. He also showed that, by the combinations of the scalene triangles resulting from his process, a series of rectangles was produced, and proved that these rectangles had peculiar harmonic qualities, that belonged to no other figures of the same species. He stated that such a scale was a desideratum in architecture, and that its adoption would be attended with incalculable advantage in that as well as in every other art in which form was treated in the abstract. He also mentioned that his scale of harmonic forms was applicable to curvelineal as well as rectilineal figures, and that he was engaged in a work in which this should be proved.

2. *Description and Drawings of a Circular Saw for general purposes, but more particularly for Agriculturists.* By Capt. G. D. Paterson.—This saw, it was stated, is adapted both for cross-cutting and all other kinds of work, but more particularly for running cuts through battens, deals, &c., and can travel through timber of any length. In cross-cutting, the workmen can cause the saw to advance or retreat by means of a handle. For long work the saw is driven backwards and forwards by machinery. Captain Paterson adopted the plan of making the saw travel instead of the wood, not only because by that means greater precision is obtained than by moving the wood to the saw (which indeed, in cross-cutting large trees is almost impracticable), but also in order to avoid the risk of crippling the saw, which he had often known to occur from careless or inexperienced workmen twisting the wood in the act of cutting. The saw is driven by belts.

3. *Description and Drawings of a Railway Indicator.* By William Anderson, mail-guard.—The machine, as it has been in action for three months past on the Dundee and Arbroath Railway, was exhibited. The indicator shows, at any moment, the number of miles the train has travelled from the station at which it started, as well as the number to travel to the end of the journey. It also enables the engineer or any other person in the train to ascertain at night or in dense fogs, within a few feet of the particular spot on the line upon which the train is travelling. It also tells the rate of speed, and the different stations and localities which the train passes; and also the hour and the length of time it takes to run every mile. It was stated that it would be an effectual check to careless or reckless driving, and would be also a complete check upon book-keepers, conductors, and every other servant connected with the train, as at the end of the journey it has only to be examined in order to show the time when the train started—when it reached every one of the different stations—and the precise speed at which it had travelled during any part of the journey; and were its indications copied into a book, this would form a complete and lasting register of the whole working on the line.

A tail Signal Light, to be attached to the upright spindle of the indicator, was also described, viz. a revolving red and white light, which would show at night the speed of a train in advance of another at a distance of four or five miles, and thus enable the driver of the following train to keep at a proper distance from the one in advance.

4. *An antique cabinet Lock and Key of curious and ingenious workmanship*, was exhibited by Adam Gib Ellis, Esq., W.S., F.R.S.S.A.

5. *A Model of* Mr. W. G. Gover's *Removeable Window Sashes for the more easy and safe means of Cleaning Windows entirely within the apartment.*—The advantages of the invention are stated to be, that the iron corner-pieces strengthen the sashes, and render them removeable, and capable of being taken inside the apartment to be cleaned. They also cause the sash to slide more freely and silently in the frame; and when closed, the window is perfectly firm, and free from any rattling or vibration. They can be applied either to new or old windows at a cost of 10*s.* per window.

ARCHÆOLOGICAL INSTITUTE.

January 9.—Sir Richard Westmacott in the Chair.

The increasing number and interest of the communications submitted to the Institute has induced the Committee to devote two meetings in each month solely to the exhibition of antiquities, and to archæological discussion.

The first of these conversazioni was held at the apartments of the Institute (12, Haymarket), on Friday last at four o'clock, as had been announced in the printed circulars of the Committee and the recently published number of the *Archæological Journal*.

On opening the proceedings, Sir R. Westmacott observed that, before entering into an examination of the objects submitted to them, he thought it right to state, that it was far from the intention of the committee of the Institute, in holding these meetings, to interfere in any degree with the proceedings of the Society of Antiquaries. He conceived that there was a marked distinction in the province of the two societies. It was competent to the Society of Antiquaries to undertake far more important objects;—its range of research was wider, its resources were more ample. The Institute was necessarily subsidiary—designed to act in a pioneer capacity, and to supply by its extended correspondence those materials not otherwise accessible, on which the more important labours of the Society of Antiquaries must ultimately be based. The constitution of the Institute was so framed as to embrace all classes interested in the study of Archæology,—not those only whose support was valuable from their position and influence, but also those precluded by their limited means from joining the Society of Antiquaries, and deriving full benefit from its valuable publications. By this more comprehensive enrolment, the Institute hoped to secure the co-operation of those who were the official conservators of our great ecclesiastical edifices, and those also whose professional education involved the study of Archæology; and of the national sympathy thus created the Society of Antiquaries would, he felt sure, reap the benefit. He confidently anticipated that, by the annual meeting, a very great stimulus would be given to the study of Archæology, and that in each successive visit a new and interesting locality would be explored and illustrated, and many precious objects, which lie concealed in private collections, would be brought to light. By the smaller meetings, such as the committee held this day, they hoped to give the opportunity for much friendly intercourse and valuable discussion. He rejoiced to see, on the present occasion, such a variety of interesting objects and communications as those laid before them,—a most gratifying assurance of the manner in which these meetings would be supported by the members of the Institute; and he could only regret that the limited space of their apartments did not allow them to accommodate, on the present occasion, a larger assembly.

Sir Richard then called the attention of the meeting to some beautiful Italian sculptures in ivory, which had passed into his possession from the collection of Flaxman. He observed, that they probably represented, in a series of groups, the incidents of some legend or mediæval romance. They appear to have been executed in the earlier part of the fourteenth century, and afford a remarkable example of a peculiar style of design, considered by foreign antiquaries to be Venetian, and of which several specimens may be seen in the Musée Charles X. at the Louvre, and several private cabinets at Paris and other parts of the continent. He also submitted for inspection a head sculptured in stone, of the 13th century, from Hereford Cathedral, remarkable for the fine character of the features and general expression.

The Marquess of Northampton exhibited a bronze Etruscan vase, of unusual form, found at Bomazza, and a mirror ornamented on the reverse with an engraved group of the Judgment of Paris, and a number of beads formed of vitreous pastes, discovered near Rome, much resembling the beads found in British barrows.

Several interesting primeval weapons of flint and bronze, discovered in Glamorganshire, belonging to the museum of the Royal Institution of South Wales, were communicated for exhibition, by permission, through Mr. G. G. Francis, local secretary to the Institute. A valuable illustration of these remains was contributed by Mr. J. Winter Jones, consisting of an unique assemblage of lance and arrow heads of silex, discovered in Canada, which, as Mr. Birch remarked, closely resemble in form and adaptation the weapons of the primeval tribes of Great Britain and Northern Europe.

Mr. Dilke exhibited a portrait on glass of late Roman times, purchased at Strawberry Hill, representing a female bust, and that of a boy wearing the bulla. This portrait is remarkable, not only from a variety of details of classical costume, rarely to be met with, but also as an example of ancient design, showing a great knowledge of form and chiaroscuro. The head-dress of the female resembles that of the Empress Julia Momœa, and the portrait is probably not later than the time of Gordianus Africanus. The mode in which the work is executed is also curious: it is apparently formed by scraping way parts of a black pigment, so as to show a gold ground below, the surface of the picture being protected by a glass plate cemented over it. Another beautiful portrait of the same kind was exhibited by Mr. Burgon; and other examples of this species of glass have been noticed by Buonarotti, in his work on ancient glass.

Mr. Talbot exhibited a warrant for the payment of 55 sols tournois to Ristandore, trumpeter of the Comte d'Angoulême, for bringing the "good and joyful news of the death of Talbot and the defeat of the English before Castillon," in the year 1453. Mr. Talbot also exhibited some Roman silver Imperial coins from Vespasian to Severus, found near the Giants' Causeway in Ireland, and a Chinese porcelain phial said to have been found in a tomb at Thebes.—Mr. Birch stated that all these phials were probably very much later than their alleged date; first, from their being inscribed with a character not earlier than the first century B. C.; secondly, from the fact that in the Chinese annals the first mention of porcelain does not occur till the seventh century A. D., and then it is spoken of as a rarity; thirdly, that the merchants were in the habit at the present day of bringing these vases to Cairo on the return of the caravans from Mecca.

Mr. C. Villiers Bayly exhibited a slab of wood, probably part of a coffer, ornamented, and with groups in relief and pounced work, supposed to represent a subject from some romance; the costume of the figures was Italian, of the latter part of the fifteenth century.

Mr. Poynter exhibited some stamped leathern hangings of beautiful design, from Bradwell House, Bucks; they presented a good example of the decorations which supplied the place of hangings of Arras, towards the close of the seventeenth century.

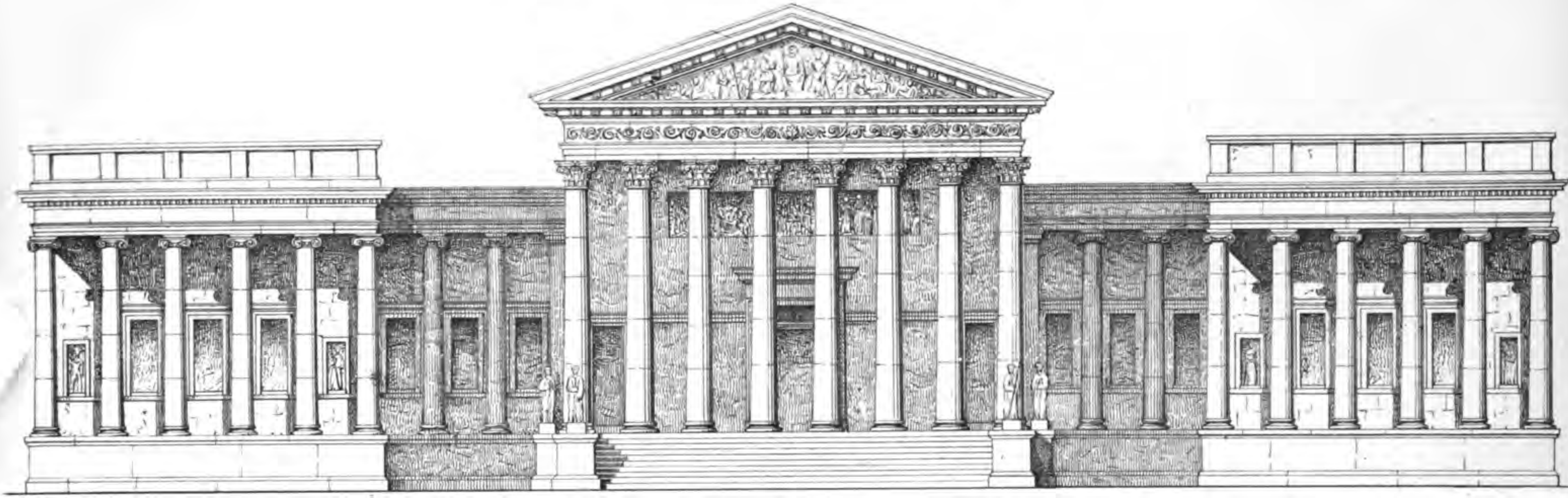
Two drawings, on a very large scale, of early Christian, inscribed and sculptured crosses at Nevin and Carew, in Pembrokeshire, were exhibited by Mr. Westwood. Mr. Westwood stated, that these were the two finest specimens of this class of monument that he had been able to discover, and that their date was probably the eleventh century.—The representation of a remarkable sculptured monument, at Auldbar, near Brechin, was exhibited at the same time, and several features of resemblance in design were noticed. This curious early Christian memorial had been communicated to the Institute by Mr. Chalmers, of Auldbar.

Several communications were read to the meeting, among which was a letter from Sir Philip Egerton, stating some singular facts connected with the Roman occupation of Cheshire, as detailed by Mr. Hostage, of Northwich. Letters were also read from the Rev. Hugh Jones, D.D., and the Rev. H. Longueville Jones, announcing their intention of commencing excavations on the site of Segontium, near Caernarvon, where it was anticipated that interesting discoveries would be made. Dr. Jones stated that the walls of Caernarvon Castle had recently been repaired in a most satisfactory manner, but that some portions of the town walls, the property of Mr. Asheton Smith and Lord Newborough, were in a very decayed state.

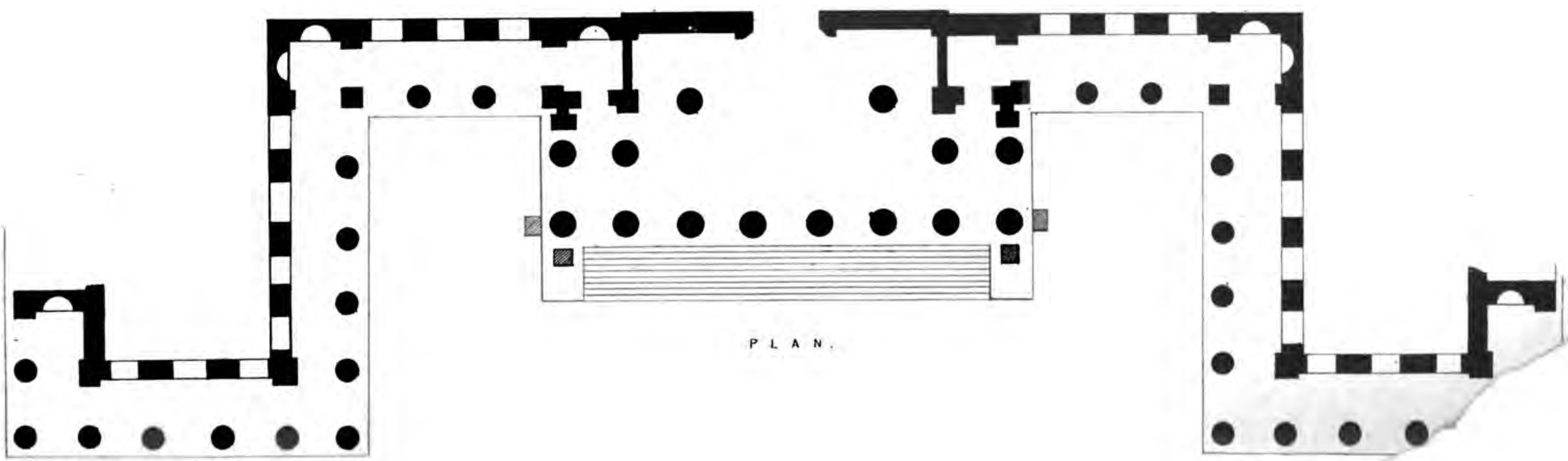
DECORATIVE ART SOCIETY.

A continuation of the paper "On Chromatic Decorations in England," was read by Mr. E. Cooper. He commenced by noticing the progressive regard for coloured decorations exhibited during the Norman and Gothic epochs; alluding to the simple and chaste effect produced by the polished Purbeck marble shaft at Ely, and the Temple Church, the rich grandeur of the earlier stained glass windows at York and elsewhere; with the attendant painted decorations on ceilings and walls, and the pavements of encaustic tiles. He attempted to elucidate the principles which predominate in the better examples, by explaining the general application of the three primary colours, and the more usual construction of the designs. He then noticed the stained glass windows at King's College, Cambridge, where the whole of the subject and detail are designed with a feeling of Renaissance (it is supposed by Giulio Romano); he said, from personal observation, that nearly all the coloured glass is what is technically termed pot-metal, so that where it is not so, as probably in the finest colours, it is enamelled glass; and he observed that drawing and shading were placed upon these, as is evident from the disappearance, in many cases, leaving the pot metal only. A *disconsonance* was alluded to, arising from the colours of back-ground and fore-ground in pictorial subjects being of the same intensity; and a method of producing light and distance by removing more or less from the thickness of the enamel was suggested as applicable to windows, and a specimen was exhibited. Mr. Cooper then commented on the agreeable effect of stained glass windows when the walls are of a simple or uniform colour, but urged careful consideration when the walls are decorated with pictures. He observed that the altar-piece at King's College is entirely neutralized in effect by the overwhelming coloured rays of light entering in every direction upon it; the earlier examples of Gothic windows were said to allow the transmission of a greater proportion of pure light. He maintained that the ancient coloured glass had no superiority over that now produceable, and that the prevalent opinion of inferiority had arisen from the greater use of *painted*, instead of *pot-metal or enamelled glass*. After some remarks on encaustic tiles (specimens from Reading Abbey), and the peculiarities of Gothic drawing, colouring, and sculpture, Mr. Cooper described some examples of transition, or mixed Gothic and Italian character in the ceilings of the Chapel Royal, St. James's, and the chapel of Bishop West, in Ely Cathedral; also the fine specimens of baronial decorations lately restored at Hampton Court. He then took occasion to censure the manner in which some of the coloured decorations in the spandrils below the windows of the aisles in Westminster Abbey have been destroyed or concealed by misplaced and absurd mythological monumental tablets; and he noticed some fine and well known examples of "high tombs," richly ornamented with marble, colour, and gilding. The decorations of the Elizabethan period were noticed, and a specimen of embossed, silvered and coloured leather hangings from the Manor House, Billingshurst, was exhibited. The introduction of Italian architecture, by Charles, led to the consideration of the ceiling of the Banquetting House, Whitehall, painted by Rubens, also of the works by Thornhill, Verrio, Languerre, and Charles de la Fosse at Greenwich Hospital, St. Paul's, Chatsworth, and Montague House (late British Museum). At present, he remarked, there appears to be a struggle for supremacy between the Gothic and Italian styles; and, in his criticisms on some recent decorations, Mr. Cooper expressed an opinion that the imitations have been unsuccessfully applied, instancing those in the Temple Church as partaking too freely of yellow ochreous tints, the Royal Exchange as being too *petite* and paltry for their purpose, the Conservative Club as presenting a bewildering profusion of trifling ornaments devoid of any important character

IDEA FOR THE FACADE OF THE BRITISH MUSEUM.



ELEVATION.



PLAN.

or design, and materially diminishing any grand effect that the architect might have contemplated. After some remarks explanatory of his views on domestic decorations of the present day, Mr. Cooper submitted a question as to the applicability of *Gothic decorations to modern purposes*, with more especial reference to the New Palace of Westminster; he admitted that decorations should be in accordance with the style, and subservient to the architectural character of the edifice; but, he asked, must we therefore follow the earlier Gothic mannerisms? Copy the attempts of an age of comparative barbarism in Art? Or, are we to adopt all the improvements and knowledge of form of the present day? He contended that the Gothic did not admit of pictorial decoration in proper keeping, and that the modern school of painting presented too many inconsistencies. He concluded by asserting that the Italian style of the fifteenth and sixteenth centuries, as found in the designs of Palladio, Scamosi, Sansovino, and others, admitted of the utmost degree of refinement, both in sculpture and painting, and afforded profitable materials for study for such a purpose.

INSTITUTION OF CIVIL ENGINEERS.

Extracts from the Annual Report.—Session 1846.

Premiums.

Telford Medals, in silver, have been awarded to Philip Chilwell De la Garde, for his "Memoir of the Canal of Exeter, from 1563 to 1724," and to George Edwards, M. Inst. C.E., for his paper "On Blasting Marl Rocks under water in the River Severn."—Premiums of Books, suitably bound and inscribed, have been awarded, to John George Bodmer, M. Inst. C.E., for his paper "On the advantages of working Engines with High-pressure Steam expansively, and at high velocities, &c.;" to Benjamin Lewis Vulliamy, Assoc. Inst. C.E., for his paper "On Railway Clocks;" and to John Baldry Redman, Grad. Inst. C.E., for his "Description and Drawings of the new Cast Iron Pier at Gravesend."

Obituary.

The deceases are few; they are Robert Thomas Atkinson, Member, and Lieutenant Edward Nicholas Kendall, R.N., and John Llewellyn, Associates.

Mr. Atkinson was the nephew of the late Mr. Buddle, and after being brought up by him, assisted him for some years in his large mining and engineering undertakings in the North. Not long before his death he took the management of the Seaton Delaval mines, where he is stated to have displayed great talent and judgment in difficult positions. His communication to the Institution in the session of 1842, "On sinking and coffering pits in the North of England," will be recollected by the members and increase the regret which must be felt for his loss.

Lieutenant Kendall, whose grandfather, Admiral Hicks, and father, Captain Kendall, were both distinguished naval officers; received his education and became first boy, at the Royal Naval College, Portsmouth. He entered His Majesty's service as a Midshipman in 1814, on board the Mutine. He served with credit in several other ships, and from his scientific acquirements was chiefly employed on the surveying service; upon the trigonometrical survey in Orkney, Shetland, the coast of Ireland, and in the North Sea. On the fitting out of the Polar expedition, under Captain (now Sir Edward) Parry, he volunteered his services, and acted as Master's Mate on board the 'Fury,' Captain Lyon. He was subsequently selected by Captain (now Sir John) Franklin, as one of his companions for the land Arctic expedition, and returned with the proud distinction of being attached to the only one of the Polar expeditions that had completely effected its objects. The charts, drawn up by Lieutenant Kendall, from the astronomical observations made by Sir John Franklin and himself, remain as evidence of his talent and industry. He was then appointed, at the recommendation of the Royal Society, to the 'Chanticleer,' for the purpose of assisting the late Captain Henry Foster in a series of experiments on the pendulum, and various other branches of scientific research in the Equatorial and South Polar regions. He then conducted the survey of the Western Coast of Africa in the 'Hecla,' the officers of which vessel had nearly all fallen victims to the climate. He was then employed by the Secretary of State for the Colonial Department, in a secret and confidential survey of the boundary line of the British and American states, in New Brunswick, and executed his task in the most satisfactory manner. On his return he compiled a complete map of the province of New Brunswick, from his own astronomical and other observations. He then turned his attention to the subject of Steam Navigation, and after superintending for a Joint Stock Company, the building and fitting out of the 'India' steam ship, which was destined for opening a direct communication with the East Indies, viâ the Cape, he was appointed to a post under the Royal Mail Steam Packet Company, which he only held for a short time, and then became the agent at Southampton, for the Peninsular and Oriental Company; and the Directors and all who knew him in that capacity, bear testimony to his zeal, talents, and high integrity. While holding that position, he was attacked with sudden illness, and expired on the 12th of February, 1845, in the prime of life and usefulness, being only in his 45th year. He made several useful communications to the Institution, and attended its meetings as frequently as was compatible with the nature of his engagements.

SOCIETY OF ARTS, LONDON.

The second ordinary meeting for illustration took place on Jan. 21, at the Society's House, Adelphi. Edward Speer, Esq., in the Chair.

The following communications were made—

1. *On the theory of Photographic Action, illustrating the connection between the Photographic agent and Electricity.* By J. Nott, Esq.—The substance of this highly important and original paper, which led to an interesting discussion, and was to be resumed at the next meeting, was as follows. "Since the discovery of Photography there is, perhaps, no branch of electrical physics more interesting than that which comprehends the phenomena of phosphorescence. For though light be the apparent agent in the production of the photographic picture, yet the accompanying circumstances can only be satisfactorily explained by a reference to electrical principles. Light is a term merely relative to us, but light itself has no absolute existence no more than sound; then how unphilosophic are the terms, latent light and light in darkness, which we sometimes hear, as if that which is merely an effect, could be regarded as a cause, or a physical force, at the same time that we know it is not possible to demonstrate the existence of any other physical force in nature than electricity.

"Light is, therefore, only an attendant circumstance in the production of the photographic picture, and this seems clearly proved by the fact of one body impressing its image upon another in the dark, when the bodies are approximated in electrical phraseology is called the striking distance.

"As light then cannot be regarded as the photographic agent, electricity, which in all probability is the principle of light, would seem to be, and the effects produced when phosphorence is developed through juxta-posed transparent media, of different densities or electrical affinities, bears a striking an analogy to those which are produced upon a sensitive surface, when exposed to the action of light reflected from bodies in different degrees of intensity as to render it more than probable, that what is understood by the term photography, is a simple case of phosphorescence by insulation. For we find that some parts of the sensitive surface, then exhibit what may be called an elective affinity for certain substances, while others do not. The results can only be the effects of simultaneous attractions and repulsions, the manifestation of which is inconceviable independent of the presence of electricity.

"The question then arises, if the photographic picture be the result of electrical action, why may not the colour as well as the contour of bodies be taken down, seeing that colour is not a property matter, but as a property of light. All bodies are seen only by reflected light, and their colours vary in tint according to the position of the spectator with respect to the plane of reflection. For instance, in the normal of the plane of reflection, the colour of bodies is most distinct, and at every deviation from this point, the local tint changes, and in many cases, is totally extinguished when the eye of the spectator reaches the angle of total reflection. Thus then, where the reflected light is the strongest, the colour of bodies is least perceptible, and *vice versâ*.

These considerations induced me to try what comparative effect would be produced upon a sensitive surface, by light reflected at various angles of incidence from the plane of the picture.

"The effects which were thus produced were quite analogous to those which are observed in nature, the local tints of the bodies represented varying with every change that was made in the angle of reflection in which the picture was taken down, and the direct ray invariably gave less picturesque results than when a parallel glass was used. In some specimens taken with the parallel glass when they were looked at directly, all the appearance of a radiating reflection were presented, and when looked at obliquely, all those of a speculary reflection, as if the sun were actually shining within the photographic picture itself.

These results gave promise that some remarkable effects would be produced by polarized light, I therefore had a small sundial made, the style of which was formed by a bit of very fine silver-wire, and from the centre of the dial a bit of the same wire was erected perpendicularly, so that the hour angle and the sun's azimuth were given at the same instant.

By means of this instrument Mr. Nott observes, he was able to determine with a good deal of accuracy, the position of the sun, with respect to the plane of the picture that he wished to take a photographic representation of. The glass of the camera was also made adjustable to the polarizing angle by an attached graduated quadrant.

When, by these means the light was polarized into the camera, by a double reflection from the plane of the picture, and from the parallel glass it was found that the objects in deep shadow and those in sun-light were taken down simultaneously and with equal precision, and that without the slightest trace of solarization, exhibiting a sun-light view of the greatest truth and beauty, in which the transparency of the shadows and the effect of the distance produced by an exquisite gradation of tint, such as art could scarcely hope to imitate. This result of polarized light seems doubly interesting since the recent and beautiful discovery of Faraday, where a ray of extinguished polarized light is reillumed by electricity.

How far this discovery may enable us to determine the nature of the active agent concerned in the production of the photographic picture, we will not at the present moment presume to decide.

2. *On the new Patent Oil Integument, or skin of Paint*, by H. Page, by which great facility is afforded for interior or exterior decoration. The author, after pointing out the various inconveniences which the public experience in having the painting, graining, and oil decorations done on

the premises, proceeded to show some of the advantages which he obtains by substituting a prepared skin of paint for the ordinary common painting. These advantages are very apparent in the decoration of ceilings, or in the execution of any kind of flat ornamental work, whether it be imitations of woods, marbles, lettering in gold or colours, on walls or wood-work, as it is only necessary that the dimensions of the parts to be ornamented should be previously taken, and the work can be completed at the artists' shop or study. He next proceeded to describe the process of manufacture, remarking, that the skins at present made are 12 feet by 3 feet, that being found the most convenient size, but they can be made of any dimensions. A sheet of elephant, or any stout paper, rather larger than the skin required, is taken, and the surface on one side only is prepared with a mixture of gum arabic, treacle, and water, upon which when dry a coat of paint made with boiled oil and white lead in the ordinary way is put upon it; when that is dry, the operation is repeated till the skin is of the required thickness, but two coats are found to be sufficient for general use. To separate the skin from the paper it is laid on a clean board, with the painted side downward; the paper is then wetted at the back with clean water, and after it has stood a few minutes, the paint may be removed without any difficulty or the least fear of its tearing. The same paper may be painted on thirty or forty times, but must always be prepared as described above. The paint where removed is carefully wiped with a sponge and then dried with a wash leather to remove any portion of the preparation which adheres to it. The skin is then folded and put away till such time as it may be required for use. The mode of fixing the skin is to rub down the surface to which it is to be attached, and, when thoroughly clean, it is gone over with boiled oil and gold size; a smear is sufficient. The skin is then laid on with a soft cloth, as in the ordinary paper-hanging. Several beautiful specimens were exhibited.

INSTITUTE OF BRITISH ARCHITECTS.

January 12.—H. E. KENDALL, Esq., V.P., in the Chair.

A paper was read by John Britton, Esq., *descriptive of Roslyn Chapel, near Edinburgh*. This edifice was commenced in 1446, and his widow and successors continued the works, which had been left unfinished at the death of the founder, in 1479. Mr. Britton observed, that his attention had been directed by Mr. David Roberts to the aisle at the east end, which is wider than the other; and it would appear that the plan had been changed after the stone-work for the vaulting was prepared, and in order to make it available, the architect had resorted to the expedient of carrying the arches upon large projecting corbels,—a remarkable feature in the construction, which it would be difficult otherwise to explain.—Mr. Burn observed, that the picturesque tradition (so well handled by Sir Walter Scott) of the interment of the Sinclairs, shrouded in the armour and uncoffined, in a vault beneath the chapel, is destitute of foundation. There is a crypt, not under, but beyond the chapel, to the eastward, which Mr. Burn believes, on a careful examination never to have been used as a sepulchre; and there is only one other small vault, where some of the family have been deposited in oaken coffins.—Mr. Fowler observed, that the nave of the building was vaulted on the uncommon, though not singular principle of a solid roof, the extrados of the arch forming the external covering. The vaulting of the east end aisle is remarkable for its excessive flatness, and appears to have been retained in its place by iron ties grooved into the stones—a singularity in the construction of the Middle Ages.

Mr. Donaldson read a letter from Mr. Knowles, from Athens, describing some late discoveries made in further disencumbering the Acropolis of its rubbish. One result has been to ascertain, that the interior of the Parthenon was supported by columns of the Doric order, 3 ft. 7½ in. in diameter, of which the fluted contours remain traced on the pavement. Mr. Donaldson made some remarks on the model of the Parthenon by Mr. Lucas, exhibited at the British Museum, in which the lower range of interior columns is represented as of the Ionic order, and promised some further remarks on this subject at a future opportunity.

STEAM ENGINE.—At the *Academie des Sciences*, Paris, Dec. 20, M. A. Segnier read a notice of a new steam engine, the invention of Messrs. Isoard and Mercier. After describing the construction of this engine, M. Segnier says:—"It differs from all that has hitherto been invented, not only in its construction, but also by the special manner in which the steam is employed. Instead of being conveyed from the generator to the motive apparatus, and undergoing on the way, or at the moment when its action is required, all the losses due to the diminution of volume by the causes of the cooling process, the steam is maintained at a very elevated temperature in the generating tube, and the relations of the heated surfaces and of hot water injected are calculated in such a way that the heat does not escape by the orifice until it has acquired an increase of temperature which permits it to act at once as steam and as dilated gas.

A VIEW TAKEN OF A REVIEWER;

In a Letter to the Editor of the Civil Engineer and Architect's Journal.

[We are compelled by an unfortunate misprint at p. 13 of this journal, and from an anxiety to avoid all appearance of injustice, to give insertion to the following letter. It is rather of a philological than architectural character, and this, together with a full appreciation of the writer's merits as an architectural critic, renders it wholly unnecessary for the Reviewer to enter upon a detailed reply. We have taken the liberty of omitting one or two passages in which the writer's feelings have betrayed him into personality. The misprint of the word "façade" was marked on the proof-sheets, but the correction was neglected by the compositor.]

SIR—To crave as a particular favour, or favour at all, what I can demand as an act of justice, would be no particular compliment to yourself personally. It would imply that I thought so meanly of you as to suppose that you would not feel yourself sufficiently bound by your own sense of honour and honesty to afford me, as mere matter of course, the opportunity of exposing in your own Journal the not only very unfair but actually falsifying remarks which the "Review of the Companion to the Almanac" has rendered it the vehicle of. I need not adopt the submissive tone of a petitioner, nor do you require to be tickled by dainty phrases into doing what your own feelings must prompt you to at once, or if not your feelings, mere regard to your own interest and to the character of your publication.

Your very clever Reviewer has blundered in the oddest manner throughout, and has committed both himself and your Journal. If not a downright blunder, it was surely a piece of great indiscretion on the part of the "Civil Engineer" to assail, or suffer to be assailed all at once, in its own columns, and that, with rancorous spite, and undisguised hostility, that very portion of the Companion which the Journal itself has hitherto especially and almost exclusively noticed, and has recommended to its own readers, as containing much interesting architectural description, remark and information. I do not say that because the Companion had all along been spoken of favourably—at least civily by the "Civil Engineer," the latter ought for mere consistency's sake, to have continued to speak of the Companion in the same tone as formerly. In the course of time, publications of the kind are apt to alter—and after greatly for the worse. They quite lose their original spirit and character, and merely live on upon the reputation which they have acquired during their season of vigour. Such unfortunate change may have come over the "Companion:" its architectural writer may be in the condition of the poor archbishop of Grenada, and your Reviewer has kindly undertaken to be its honest, and disagreeable *truth*-telling Gil Blas. A change has of late come over even your own Journal, although it has not numbered quite so many years as the Companion, consequently has not become superannuated. That change, however, is of course one decidedly for the better. Still, it has in some respects been rather a too sudden and startling one. Most of your readers must have been not a little astonished by the "Review" in question. If the Companion—by which is to be understood the architectural part of it—has altogether degenerated, and is no longer of any interest and value, it might have been coolly dismissed or have been passed over without any notice at all.

Between not speaking favourably of a publication, and speaking of it abusively, there is a wide difference,—a wide difference between not praising, and coarsely reviling. Wide as it is, your "Reviewer" has displayed his agility by leaping over it at a single bound. In performing which notable feat he has, unluckily, jumped plump into a quagmire. Let us hope, Mr. Editor, that he has not dragged your Journal into it at the same time.—In his hurry to fire his *blunderbuss* at the Companion, he overloaded it so incautiously that it has recoiled, and laid him sprawling.

Intended to be severe, his remarks show chiefly impotent savageness; and if he does not actually foam at the mouth, he has discharged a great deal of nonsensical froth from his pen. As to severity, I can be severe myself; perhaps, Mr. Editor, you think me so now; it would, therefore, as ill become me to exclaim against that "*qualification*,"—or what looks like it—in your Reviewer's observations, as it has done him to protest so lustily against every—even the most innocent species of artifice, sham and deception, at the very time that he was imposing upon the readers of your Journal his own distortions and manglings of words and meanings, as remarks actually made in the Companion.

Such being the case, I might very well pass them over as too contemptible for notice. Undoubtedly, I might do so—most others, perhaps would do, because that same "too contemptible for notice," is a very cheap and convenient mode of showing one's philosophy. I also should perhaps have adopted it, had not the Reviewer among his other fabrications, hammered out and sharpened weapons to be turned against himself. There are in the world those who can very heroically submit to bear any amount of contempt so long as it is not expressed publicly. It is not the mere contempt itself, but the publicity of it, which at all touches them. Besides all which, however contemptible the matter may be in itself, the opportunity of turning a Reviewer completely inside out is by far too tempting. It is not every day that a similar one presents itself, and perhaps it is better so than otherwise.

As I have already said the Reviewer's perversions and misrepresentations are so gross as instantly to expose themselves, yet very few readers indeed take the trouble of comparing a Reviewer's remarks and quotations with the book itself that happens to be under notice. And your Reviewer must not only be of such opinion, but must have felt pretty well assured in his own mind either that no readers at all ever do so, or that the "Companion" was of all books in the world the most unlikely to fall in the way of the readers of the Civil Engineer, else he would hardly have ventured upon assertions calculated to induce people to turn at once to the Companion, for the purpose of ascertaining whether the remarks on Public Improvements were as nonsensical as he has represented them.

The Reviewer commences his attack on that chapter in the Companion with what is rather an unlucky slip for a gentleman who pretends to take others to task, for carelessness of expression, and inaccuracies of language, giving it as his opinion—and a Reviewer's opinion can be nothing less than a *plumper*—that the new range of buildings near the Royal Exchange, called "Freeman's Place," is praised for the "*qualification*"! which it least of all possesses. Here, then, we find "qualification" confounded with "quality," and though what the writer means to say is obvious enough, he has no right to expect that his own meanings will be indulgently made out for him, when he himself studies to misinterpret the at least equally plain meanings of other writers. Perhaps he thought that "qualification" being the longer one, was the finer sounding word of the two, and gave it the preference accordingly. Still, however awkwardly expressed, the censure itself may be just; and it is certainly no slight censure upon one who pretends to speak of architecture, to say that he praises buildings for qualities which they do not at all possess;—not but that such malaprop praise has been dealt in very largely by architectural critics.

The particular merit claimed for the building above mentioned is, that it is a fine and well-proportioned architectural mass, as will hardly be disputed by those who have seen it. Therefore, in order to make evident with what painstaking ingenuity the Reviewer has proved it to be wholly undeserving of the character given it, it is necessary first to give the remarks in the "Companion" at length, and then consider what sort of fair construction the Reviewer has put upon them.

"Freeman's Place, is in a manner so connected with the Royal Exchange" (mentioned just before in the book) "to which it may be considered a sort of architectural satellite, that we proceed to notice it at once before we come to other general improvements and alterations of the kind, more especially as it distinguishes itself from all the rest by having more the air of a single large edifice, than a mere piece of street architecture. This range of building, which immediately faces the east front of the Royal Exchange, and forms the opposite side of a wide paved avenue between the two buildings, that is reserved for foot passengers only, is in a style of noble simplicity that says much for the good taste and judgment of its architects, Messrs. E. I'Anson and Son. Equally free from the usual common-place of pretensious decoration—apt to run into the meretricious, and from baldness and insipidity—apt also to be mixed up with the former, it is at once sober and dignified—with neither too much nor too little of embellishment, but consistent throughout, and all of a piece. Not only is it a fine mass as far as mere size goes, but the importance so derived, is well kept up and preserved by the character of the "fenestration," which is such as not to cut up the mass itself into littleness, as is too generally the case, owing to windows being put too closely together, which inevitably occasions an ordinary dwelling-house to prevail, in spite of every attempt to mask it by ornament; whereas this façade"—let this be particularly attended to—"is exceedingly well proportioned both as to the quantity of window opening as compared with the entire surface, and well-proportioned also in regard to mass (about 160 feet by 60 high) wherefore the eye takes in the whole of it as a distinct architectural object."

More need not be quoted, there being already enough for the purpose, and also to show the kind of writing and architectural comment in the Companion, which, if none of the best, are quite as good as what we generally get from architectural journals. Now, after reading the above, would any person in his senses suppose that by "fenestration" is to be understood merely the ground-floor windows, which, speaking architecturally and artistically, answer much better to the name of glazed arcades than of windows? The design would have been precisely the same had the ground-floor arches been entirely open, as for instance, in what is called Covent Garden Piazza. And did the Reviewer understand any thing of architecture beyond a few crude notions about it, he must know that fenestration and arcading require very different proportions in regard to the ratio between *solids* and *voids*. So desperately determined, however, is he to abuse the Companion, and "to show the ridiculous and ignorant absurdity of the criticism," that he obstinately shuts his eyes to what is meant by the term "fenestration"—for of the windows and the general composition of the façade he takes no notice—but invidiously confines himself exclusively to the ground-floor, the very part which is *not* pointed out for notice in the Companion, applying to that alone what is evidently intended to be understood as characteristic of the general mass. So, in order to give some plausibility to his own distorted representation of the matter, and to make it appear that the author of "the ridiculous and ignorant criticism" alluded expressly and exclusively to the glazed openings of the ground-floor, he converts the words "this FAÇADE," into "this ARCADE!!" * * *

Perhaps he will now attempt to say that the alteration was a mere misprint: if so, it was a most pat and convenient one at the time, and he accordingly took care not to alter *that* when correcting the proof. Yet the *mistake* is so unluckily lucky and convenient, that without it the quotation would *not have answered his purpose at all*, but would rather have told against him! He has in consequence cut off, having exerted his ingenuity, somewhat after the manner of the fellow in one of Hogarth's Election Pictures, who astride on a sign post, is sawing it through most vigorously, the result of which achievement will be, that he must certainly come to the ground.

'To make assurance doubly sure,' the Reviewer takes some pains to convince us of the marvellous fact, that when Conservatories are built to correspond with the architecture of the mansion they happen to be connected with—whether designed as arcades or otherwise—the spaces between the glazings are quite as wide as the piers of the ground-floor in Freeman's Place. What a notable piece of information! how wonderful that an arcade forming the ground floor of a street building should resemble any other arcade, more especially one used as a conservatory! Fortunate was it for the Royal Exchange that the Reviewer did not turn round upon that, and discover the aggregate surface of the windows, compared with that of the masonry, to be as great or greater than it is in many conservatories, for the reason that "the ground-floor of the building exhibits one continued series of arched window-openings, separated only by piers."

Of course he himself has seen the building—or if not, there is a partial elevation of it in the Companion to inform him what is its design, and what are its proportions. Besides seeing it, he gives us to see that he examined it very carefully—so very carefully indeed, as to see nothing at all in it except the single part which it served his purpose to look at,—which he took a "rough admeasurement of," and concerning which he had written some very rough remarks. The only thing in which he shows any smoothness is the gentle protestation—flung out as a sop to the architects themselves—that he does "not intend the slightest censure of the actual arrangement of the windows." How vastly candid and generous! how soothing and flattering it must be to them to be assured that their building is passable enough, only it does not at all answer to the character given of it in the Companion, as being a noble and well-proportioned astylar façade not cut up into littleness by too great a number of windows. How far such really is or is not the case will be rendered tolerably evident by stating, that in a frontage of 160 feet or thereabouts, there are only thirteen windows over the *terazzo* or ground-floor, which being treated as an arcade has, of course very much wider openings than the rest of the façade. The general façade is assuredly quite as solid in its proportions as those of the Reform and other palatial club-houses,—at least as regards the fenestration of the several floors, for it must be admitted, that there is not quite so much space between one floor and another as could be desired. Still, upon the whole, the Freeman's Place façade is marked by the quality—or as the Reviewer has it, by the qualification of *breadth*—by which, I ought for his benefit to explain, is not to be understood *width*.

The next subject of commentary, observes the Reviewer, is Trafalgar Square; whereupon he proceeds to comment upon the commentary in the Companion, after his own ingenious and ingenuous fashion. The *Civil Engineer* pronounced, some time ago, the two fountains in Trafalgar Square to be not only far from beautiful, but positively ugly, and not only ugly but of "intense ugliness!" which the Companion opines to be rather 'too severe,' assigning as reason for such opinion, that "the insignificance of their (the fountains) appearance is at least an equal defect." Which observation has not been thrown away on the Reviewer, for he seizes hold of it in two ways, first to broach a novel and very peculiar notion entirely his own, and next to expose the writer's false and absurd logic. According to the Reviewer, *Insignificance* of appearance and *Ugliness*,—hitherto considered two distinct and very separable, although not always separated qualities, are so incorporated together as to constitute one and the same; so that whatever is ugly must be also insignificant, whatever is insignificant, ugly; whence it should follow that what deserves either one or the other epithet in the superlative degree is superlative with regard to both attributes at the same time, and "intense ugliness" is equivalent to *intense* insignificance. Hence—if such very curious argument be worth anything,—a pigmy must be a far uglier monster to encounter than ugliest Polyphemus, or what is the same thing a hideous monster of a giant more insignificant than a pigmy. After this, it will be absurd to talk of things being "too insignificant and contemptible for notice." Nevertheless, there are some difficulties attending the doctrine and its application. 'Insignificance' has till now passed for being rather a relative than a positive quality: the same thing may be either insignificant or the contrary according to place and circumstances. What would be admired as a very elegant and tasteful ornament upon the mantelpiece of a lady's boudoir, might make but a very *insignificant* appearance in a stately and spacious saloon, yet would it therefore become at all ugly in itself?—hardly. To such awkward conclusion, however, those must arrive who go along with the Reviewer, the curiousness of whose ideas on that point of theory has seduced me into something like digression. The notion which he has briefly thrown out is by far too good to be thrown away; wherefore it is to be hoped that he will evolve, expound, and elaborate it, taking it as the germ of a new "Philosophy of Æsthetics," which, if it should not edify will at least astonish the public.

Besides the mistake of supposing there is any distinction at all between ugliness and insignificance, the Companion has committed the egregious error of assigning one defect, not as additional cause for censure, but in mitigation of very strong censure on account of some other imputed defect. Yet there is surely nothing illogical in that, unless logic consists more in verbal forms than ideas. The Reviewer excepted, every one is aware that opposite defects neutralize each other more or less; consequently what is so far from being noticeable as to be insignificant, cannot be especially remarkable or offensive for its ugliness. Neither does the remark in the Companion admit that Mr. Barry's fountains deserve to be called ugly at all. It is rather levelled against the outrageously vituperative criticism which brands them with that epithet in the hyper-superlative degree as if they exhibited the very 'præterpluperfect' of hideousness. When it was first bestowed on them, the expression "intense ugliness" seemed to be uttered very inconsiderately, but as it has been brought into notice again without any admission of its impropriety, or with the least attempt to soften it down, we must perforce conclude that it was penned deliberately at the time, and that its author still maintains it most resolutely.

That critic's vocabulary must be exceedingly limited indeed, who can find no terms for the numerous intermediate gradations between beauty and positive ugliness and the extreme of hideousness. The Reviewer seems to have only black and white upon his palette, and to daub every thing he notices with one of those two colours, as best suits his purpose at the moment.

In point of design the Trafalgar Square fountains are not remarkable for any particular beauty, neither are they so for the opposite reason. What is most to be complained of is that they are not upon a sufficiently noble scale. A single fountain equal in capacity to both the present ones would have formed a noble decoration—a far more imposing object in the centre of the square. But I forget—the Reviewer has an *intense* horror of every thing that is *imposing* or partakes of imposition. Let us, however, see what sort of imposition he can, nevertheless, stoop to himself,—what sort of sense, or nonsense he has made out of what is said in the Companion respecting the general appearance of Trafalgar Square. And here it is necessary to quote from the book.

"A more striking architectural fault as regards the enclosure or Square itself is, that the two side boundary walls, east and west, are made to slope according to the fall of the ground from north to south, although the enclosure itself is on a uniform level plane. Within the enclosure this produces a singularly disagreeable effect, for the tops of walls are not made to rise and fall like hedges according to the inequalities of the ground."

Undoubtedly, this is not so well expressed as it might have been; still the meaning is sufficiently obvious, viz. that an unpleasing effect is occasioned by the tops of those walls being made to slope, instead of being carried horizontally, and parallel to the flat pavement of the area. Yet the Reviewer has made it appear that it is complained of by the Companion, that "the tops of *the* walls are not made to rise and fall like hedges." How came that remarkably significant "*The*" to be conjured into the text?—or did it jump in entirely by accident, and just into the very place where it so admirably suited the purpose of the honest and conscientious Reviewer? Can that, too, be a mere mistake? If so, the mishaps which have occurred in printing the Reviewer's comments, are not so much mistakes and mishaps as actual miracles. Still, prodigiously lucky and convenient as they may have been just at the time, they prove anything but agreeable in their consequences, when they are pointed out. They occasion not only ugly, but "intensely ugly" suspicions; and those suspicions are rather confirmed than at all lessened when it is perceived how studiously the Reviewer labours to fasten upon the Companion more silliness than it really contains. Where did he find in the book itself such a Balaam expression as that of "making Trafalgar-square agreeable?—and, if it be not in the book, but one of his own concocting, wherefore should "agreeable" be printed with inverted commas, as if it was the very word there made use of, and the one constituting the silliness of the phrase employed. It is also in some degree made to appear that, while it speaks of Trafalgar-square as an "ill-arranged spot," the Companion calls it "one of the noblest sites in Europe," those words being also printed between inverted commas, as if a quotation from the book; which, not being the fact, the Reviewer ought to have guarded against misconception by saying, "*what has been called by some*, '(most people) one of the noblest sites in Europe.'"

It is, however, absurdity in me to talk of his guarding against misconception, when misconception and misconstruction, and misrepresentations are what he has evidently laboured at in all that he has said of the section headed "Public Improvements" in the Companion to the Almanac.

In like manner as he has reiterated his crushing condemnation of the Trafalgar-square fountains, he has again attacked—for there can be very little doubt that the former attack proceeded from himself—the new building at Lincoln's Inn, on account of deal being used for the ceilings of some of the rooms, which he not only derides, but absolutely vilifies as mere sham and deception, notwithstanding that it is the real wood which shows itself, without pretending to be any other material than what it actually is. In asserting that the members of the Inn themselves vote the ceilings in question to be Brummagem, he may be right, for if he *assists* at the "Hall dinners," he of course can best tell whether they do or not—and his veracity is of course also unimpeachable. Still, few will agree with him that the sneering exclamation "Brummagem" is at all the criticism of "gentlemen and men of educated taste." On the contrary, it is a very Brummagem sort of criticism, to which those only have recourse who have neither reasons nor arguments wherewith to support the opinions they pretend to hold.

Singularly enough too, just after seeming to allow that it is the clumsiness of the deception which renders imitative materials despicable, he is shocked at the Companion for its commending the columns in the Colosseum because they imitate white marble "most deceptively." Admirable consistency, truly! Are we then to suppose that, in his opinion, the imitation would have been all the more praiseworthy had it been less successful and less deceptive?—that the paltriness of deception is in proportion to the exactness and truthfulness of the imitation.

At any rate he has started a fresh and fertile topic for discussion—one which I must here pass over, contenting myself with keeping it in reserve for some other occasion, only remarking that the Reviewer seems to consider Design as altogether secondary to Material; wherein he shows himself to be a much more matter-of-fact kind of person than he has done as regards sticking to matter-of-fact quotation. According to his notions, Pompeii, with its stucco columns, Venice, with its so called "marble palaces," and Vicenza, with its Palladian façades of brick coated over with intonaco, ought to be scouted as exhibiting the mere Brummagem architecture. The Travellers' Club House, Pall Mall, is but of mock material; and there is plenty of Brummagem, viz. sham marble, or scagliola, not only in the other club-houses, but in Buckingham Palace and Sutherland House. Nay, there is even mock masonry—wood-work ceilings painted to imitate stone vaulting, in some parts of both York Minster and Ely Cathedral, surely, therefore, the deal ceilings at Lincoln's Inn are not such very dishonest things after all—perhaps honest enough to satisfy most people, if not one who is as straightlaced in his notions of honesty as the Reviewer has shown himself to be. * *

To your own Readers, Mr. Editor, I leave now to judge if I am the ridiculous ignoramus which your publication has represented me; and whether I am capable of writing tolerably correct and intelligible English. This letter contains some pretty plain English, and also some sufficiently intelligible and significant hints, which you ought to thank me for not having made plainer.

I remain, Sir,

Yours, &c. &c.

THE WRITER IN THE COMPANION TO THE ALMANAC.

CHRIST CHURCH, PLYMOUTH.

SIR—In reference to your observations on the fault of a "show front," the "other sides" of my church being "merely plain masonry," it is only necessary to inform you that the sides of the building *unite* with the buildings on either hand: that the Eastern end is entirely concealed, with no more than a space for light of ten feet deep; and, in short, that the front alone is visible; or that it alone *will* be visible when the intended school is built against the Southern side. The church is already built in on the *north* side. Of course, nothing *can* be worse than the *making* of an insulated building with a "show front."

Yours truly,

G. WIGHTWICK.

[Among the difficulties which architects meet with from the injudicious wishes of those who employ them, not the least is that of erecting buildings on sites wholly unsuited for them. A church of which the sides "unite with the buildings on either hand," must have three great defects: 1st. It has a show front which greatly diminishes its architectural value. 2nd. The difficulties of procuring light must be obviated by some unchurchlike arrangement: 3rd. The adjacent houses produce inharmonious combinations and secularize the character of the church.]—ED.

ICKWORTH.

SIR—In a memoir which I have just been reading of Mario Asprucci, an Italian architect who died in 1804,—and who, I may observe, is omitted not only in Nagler's Kunstler-Lexicon, but in the enormously copious Biographical Dictionary of the Society for the Diffusion of Useful Knowledge,—it is stated that he designed for "Milord Ervei," a splendid palace which that nobleman afterwards began to erect in England. By "Milord Ervei"—that "gran mecenate delle belle arti," is of course meant the eccentric Hervey, Earl of Bristol and Bishop of Derry, but is it Ickworth that is the edifice alluded to? In the "Beauties of England and Wales," that mansion is said to have been begun from the designs of two *Portuguese* architects, named *Carvalho*,—which has always struck me as an improbability. Supposing, however, the latter account to be correct, what is the other "palazzo" which "Milord Ervei" erected or began to erect in England? Or is that a mistake on the part of the Italian writer, who perhaps confounded Ireland with England, in the former of which countries there is or was somewhere in the county of Derry—the name of the place, I do not now recollect—another stately country-seat, built by the "Bishop;" and which like Ickworth was remarkable for the singularity of its plan, the body of the house, being in both instances, an ellipsis.

Whether the mansion in question be really Ickworth or not, the designs for it were engraved and published, that circumstance being alleged as sufficient reason for merely mentioning that specimen of Asprucci's abilities, "che tutti, perché inciso, *bastamente conoscono*"—it being what is so well known to every one by means of those engravings. Be they ever so well known in Italy, no copies of such work or engravings seem to have reached this country,—at least not for sale; nevertheless I take refuge in the *possibility* of their having been seen by some one among your readers and correspondents, who in such case will *probably* communicate what he knows respecting them. If no one else, the present Marquis of Bristol, no doubt, can, and no doubt also, would afford me the information which at present I endeavour to elicit through your Journal. I dare say it would be the very first and last time of his Lordship's being ever troubled with so *eccentric* an application—one paying him the compliment of my taking such very strange interest in his mansion at Ickworth.

Strange as in the opinion of most persons such course would be, in my own opinion it is infinitely more strange that so remarkable a piece of architecture as that mansion is, should have altogether missed the celebrity which many structures far less deserving of it have obtained. Most of the houses shown in "Vitruviussis" "Views of Seats," and similar collections, are scarcely worth showing at all—as studies, or as architecture mere nullities—things not worth the powder and shot of engraving them; whereas Ickworth is unique if only on account of the lavish display of sculpture in *relievo* on its exterior. Yet do those who can tell to a hair's-breadth every admeasurment of the Parthenon, know not of even the existence of Ickworth.

I remain, your's, &c.,

ECCENTRIC.

REGISTER OF NEW PATENTS.

If additional information be required respecting any patent, it may be obtained at the office of this Journal.

PURIFYING OF GAS.

HENRY PHILLIPS, of Clist Honiton, Devon, Chemist, for "*Improvements in purifying Gas.*"—Granted April 15; Enrolled Oct. 15, 1845.

In the purifying of gas by lime two means are resorted to, called the wet and the dry lime processes; in some works one only of the two processes is used; in other works both processes are used consecutively, and the lime employed for each process (where both are used) is fresh lime. The object of the present invention consists in using for the wet lime process the lime which has been previously employed for the dry lime process, by which a considerable saving of lime will result. The gas is first passed through the wet lime purifiers, and then through the dry lime purifiers; new or fresh lime in the ordinary manner is employed for the dry lime process, and afterwards this lime is used for the wet process, to be immediately mixed with water, in a vat, vessel, or other receiver, to prevent it from becoming hard—which lime, by means of additional portions of water, is brought to the proper consistency for the wet lime process in the same manner as if using fresh lime for such purpose; and such mixture of lime is applied in the ordinary apparatus used for the wet lime process.

PROPELLING RAILWAY CARRIAGES.

ELIJAH GALLOWAY, of the Strand, for "*Improvements in propelling railway carriages.*"—Granted April 10; Enrolled Oct. 10, 1845. (*With Engraving, Plate* III.)

This invention is for certain improvements in rope traction, the object being to propel the train of carriages at a speed greater than that of the travelling or propelling rope, and is effected by means of an apparatus termed a "drag," attached by any convenient means to the first carriage forming the train. The following is a description of the apparatus, reference being had to the drawings of which fig. 1 is an elevation; fig. 2 a plan; and fig. 3, an end view. Similar letters denote corresponding parts in each figure; *a a*, is a rectangular or oblong frame supported on travelling wheels *b b*, which run upon auxiliary rails placed within those upon which the train of carriages move, the whole apparatus being so constructed as to pass underneath the carriages forming the train, or in other words that the train shall pass over the drag. *c c'* are two shafts supported at each end in suitable bearings at *d d*; upon each of the shafts *c c'* there are pullies *e f*, of different diameters; *g g*, *h h*, are two ropes extending the whole length of the line, the one marked with the letters *g g* being a travelling rope, the other marked with the letters *h h*, being a fixed rope, the ends thereof being attached to a fixed point at the termini of each station. The ropes *g* and *h* pass round the pullies *e e'*, and *f f'* in the following manner, namely, the rope *g g'*, which is the travelling rope passes under the pulley *e'*, over the pulley *e*, and round the driving pullies or drums connected with the engine at each station. It will therefore be evident that if motion be given to the rope *g g'*, such motion will be imparted to the pullies *e e'*, *f f'*, the carriage or drag *a a*, at the same time remaining stationary. We will now suppose the stationary rope *h h* to pass under the pulley *f'*, and partially round the pulley *f*, and to be fixed at each end. By this arrangement it will be apparent that if motion be given to the pullies *e e'*, *f f'* by the travelling rope *g g*, such motion would be transmitted to the rope *h h*, which would (if it were loose) travel at a greater velocity than the rope *g*, in consequence of the difference in the diameters of the two pullies *e* and *f*. But in consequence of the rope *h h* being a fixed rope, it necessarily follows that such motion will be given to the drag, which will travel upon the auxiliary rails at a speed double or treble the speed of the propelling rope, depending upon the difference in diameter of the pullies *e* and *f*. By this contrivance the stationary engines will only be required to work at one-third or one-half the speed (depending on the different diameters of the pullies,) in order to obtain the same velocity as trains worked on the lines constructed on the present principle.

Mr. G. proposes at each station to detach the drag from the train of carriages which are taken up and propelled by another drag to the next station; the train of carriages in arriving at the station passes over the drag; for this purpose the carriages must either be constructed so that the drag can pass under them or a recess must be made at each station for the drag to run into, so as to lower it sufficiently for the axles of the carriages to pass over. The pullies *e e'* and *f f'* are capable of being disconnected by means of a clutch-box, so that the train can be stopped at any part of the line without stopping the stationary engines.

RAILWAY CARRIAGE BUFFERS.

THOMAS WALKER, of Euston Square, mechanic, and GEORGE MILLS, of Dover, coal merchant, for "*improvements in springs and elastic power a applicable to railway carriages and other vehicles, and to other articles an purposes in which springs or elastic power is now used.*"—Granted July 3 1845; Enrolled Jan. 3, 1846.

This invention for springs and elastic power consists in the application of steel springs or other elastic substance in combination with atmospheric air to buffers of railway carriages. Fig. 1 shows a longitudinal section of a buffer constructed according to this invention, in which *a a* is a cylinder of cast iron, *b b* are the buffer-rods which pass through holes formed in the end of the cylinder; *c c* are pistons made to fit tight within the cylinder, which is divided into two compartments by means of a diaphragm *e*; *f f* are holes in the piston, which are provided with valves opening inwards; *g g* are spiral steel springs, one end of which presses against the diaphragm *e*, and the other against the piston, so as to force the same outwards; the object of the valve is to admit air between the piston, and diaphragm during its motion outwards, which air is prevented returning or escaping from such place by means of the valve at *f*; the object of this arrangement being that should a force be applied to the buffer, such force is not only counteracted by the spiral spring, but also by the air contained within the cylinder, forming the buffer, which becomes forcibly compressed, and thereby acts as a resisting power to the opposing force.

Another modification of this buffer is shown at fig. 2, in which the inventors employ elastic bags of India-rubber placed within cylinders, and filled with atmospheric air which is supplied through openings at *g g*.

Another part of this invention consists in a peculiar mode of obtaining motive power, for which purpose the inventors have shown in the drawing a sectional elevation of an engine to be worked by the vapour of ammonia, which is contained in a boiler placed in a water bath heated to 212°. The vapour or motive power obtained from the ammonia passes through the eduction and induction pipes of a cylinder constructed in the ordinary manner, with the exception that the patentees employ India-rubber bags (similar to those described), within the cylinders above and below the piston, the object of which is to prevent the vapour escaping through the stuffing box or between the piston and sides of the cylinder.

IMPROVED ARTIFICIAL MANURE.

JAMES MUSPRATT, Esq., of Liverpool, gentleman, for "*Improvements in the manufacture of manure.*"—Granted April 15; Enrolled Oct. 15, 1845. (A communication from Prof. Liebig.)

It has been ascertained, that the growing of any crop on land, and removing and consuming it wholly from the land where it was grown, takes away certain mineral compounds; and it has been suggested by Professor Liebig, that in cultivating land and applying manure thereto, that the manure should be such as to restore to the land the matters and the quantities thereof, which the particular plants have abstracted from the soil during their growth. It has been observed in the chemical examination of marls and vegetable ashes, that the alkaline carbonates and the carbonate of lime can form compounds, the solubility of which depends on the quantity of carbonate of lime contained in the particular compound. It has further been found, that the said alkaline carbonates can form a like compound with phosphate of lime, in which the carbonate of potash or soda is partly changed into phosphate of potash or soda. Now the object of this invention is to prepare manure in such manner as to restore to the land the mineral elements taken away by the crop which has been grown on and removed from the land, and in such manner, that the character of the alkaline matters used may be changed, and the same rendered less soluble, so that the otherwise soluble alkaline parts of the manure may not be washed away from the other ingredients by the rain falling on the land, and thus separating the same therefrom. And it is the combining carbonate of soda or carbonate of potash, or both with carbonate of lime, and also the combining carbonate of potash and soda with phosphate of lime, in such manner as to diminish the solubility of the alkaline salts to be used as ingredients for manure (suitable for restoring to land the mineral matters taken away by the crop which may have been grown on and removed from the land to be manured), which constitutes the novelty of the invention.

Although the manures made in carrying out this invention will have various matters combined with the alkaline carbonates, no claim of invention is made thereto separately, and such materials will be varied according to the matters which the land to be manured requires to have returned to it, in addition to the mineral substances above mentioned. The quantity of carbonate or phosphate of lime, used with carbonate of soda or potash, may be varied according to the degree of solubility desired to be obtained, depending on the locality where the manure is to be used, in order to render the preparation less soluble, in localities where the average quantity of rain falling in the year is great; but as in practice, it would be difficult to prepare manures to suit each particular locality with exactness, the average preparation as will suit most localities will be given. In making manure according to the invention, carbonate of soda or of potash, or both are to be fused in a reverberatory furnace, such as is used in the manufacture of soda-ash, with carbonate or phosphate of lime (and with such fused compounds are mixed other ingredients as hereafter mentioned,) so as to produce manures; and such composition, when cold, being ground into powder by edge stones or other convenient machinery, the same is to be applied to land as manure. And in order to apply such manure with precision, the analysis and weight of the previous crop ought to be known with exactness, so as to return to the land the mineral elements in the weight and proportion in which they have been removed by the crop.

Two compounds are first prepared, one or other of which is the basis of all manures, which will be described as the first and second preparations. The first preparation is formed by fusing together two or two and a half parts of carbonate of lime with one part of potash of commerce (containing on an average sixty carbonate of potash, ten sulphate of potash, and ten chloride of potassium or common salt in the hundred parts), or with one part of carbonate of soda and potash, mixed in equal parts. The second preparation is formed by fusing together one part of phosphate of lime, one part potash of commerce, and one part of soda ash. Both preparations are ground to powder; other salts or ingredients in the state of powder are added to these preparations and mixed together, or those not of a volatile consistency may be added when the preparations are in a state of fusion, so that the manure may represent as nearly as possible the composition of the ashes of the preceding crop. This is assuming that the land is in a high state of cultivation, but if it be desired to grow a particular crop on land not in a high state of cultivation, then the manure would be applied in the first instance suitable for the coming crop, and then in subsequent cases, the manure prepared according to the invention would, as herein described, be applied to restore to the land what has been taken therefrom by the preceding crop.

Preparation of manure for land which has had a wheat crop grown on and removed therefrom.—Take of the first preparation six parts by weight, and of the second preparation one part, and mix with them two parts of gypsum —one part of calcined bones—silicate of potash, (containing six parts of silica)—and one part of phosphate of magnesia and ammonia. This manure is also applicable to be used after growing barley, oats, and plants of a similar character.

Preparation of manure for land which has had a crop of beans grown thereon, and removed therefrom.—Take fourteen parts by weight of the first preparation, two parts of the second preparation, and mix them with one part of common salt, (chloride of sodium,)—a quantity of silicate of potash, (containing two parts of silica,)—two parts of gypsum, and one part of phosphate of magnesia and ammonia. This manure is also applicable for land on which peas or other plants of a similar character have been grown and removed.

Preparation of manure for land on which turnips have been grown and removed therefrom.—Take twelve parts by weight of the first preparation, one part of the second preparation, one part of gypsum, and one part of phosphate of magnesia and ammonia. This manure is also applicable for land where potatoes or similar plants have been grown and removed.

The claim is for preparing and applying in the manufacture of manure, carbonate of potash and carbonate of soda with carbonate and phosphate of lime, in such manner as to render the alkaline salts in manufactured manure less soluble, and therefore less liable to be washed away by rain before they are assimilated by the growing plants.

STEAM ENGINES.

Richard Haworth, *of Bury, in the county of Lancaster, engineer, for certain improvements in steam-engines.*—[Granted February 10; Enrolled August 10, 1845.]—*Reported in Newton's London Journal.*—(*With engravings, Plate III.*)

The principal feature of novelty in the invention is as follows:—The entire working engine has both the common reciprocating rectilinear motion, and also a circular motion round the centre of the driving-shaft; the steam cylinder being fixed at one end of a lever, whilst the crank revolves loosely in a step or bearing at the other end of the same lever. The boss or centre of this lever is keyed fast upon the main driving-shaft, and is intended to communicate the motion of the engine to the same. This motion is transmitted in the following manner:—Upon one end of the crank-shaft a spur-wheel is keyed fast; the radius of its pitch line being equal to half the distance of the centres of the crank-shaft from the main driving-shaft of the steam-engine. This wheel gears into another of the same diameter, which is fixed, and remains perfectly stationary; the main driving-shaft revolving loosely through its centre: consequently, the wheel upon the crank-shaft has a double motion to perform,—one being a rotary movement round its own axis, communicated from the piston by means of the connecting-rod, as in ordinary steam-engines,—the other being a planetary motion round the main driving-shaft, occasioned by the spur-wheel upon the crank-shaft revolving, while the other wheel (through the centre of which the main driving-shaft passes) remains perfectly stationary. The wheels being both of the same diameter, the "planet-wheel" will complete its orbit round the main driving-shaft and "sun-wheel" in exactly the same space of time as the crank takes to make one revolution round its own centre. The object of these improvements is to gain both power and speed, which is accomplished by the motion being communicated to the driving shaft by a much longer leverage than usual; the increase of power being in proportion to the difference between the length of the crank and the length of the lever, in the end of which it revolves: the speed is gained by the shortness of the crank, as the piston has a smaller distance to travel at every stroke of the engine.

In Plate III, fig. 1, is a plan or horizontal view of the improved steam-engine, to be worked by high-pressure steam; and fig. 2 is a partial section, shewing more clearly the contrivance for the entrance and exit of the steam to and from the cylinder; *a*, foundation walls which support the main shaft *b*; *c*, fly-wheel; *d*, steam-cylinder; *e*, connecting-rod; *f*, crank; and *g*, the crank-shaft. This crank-shaft *g*, instead of revolving in fixed bearings, as in ordinary steam-engines, revolves in bearings at one end of the levers *h*, *h'*; the centre or boss of the lever *h*, is keyed fast upon the main-shaft *b*; the steam cylinder *d*, being attached, by bolts and lugs, to the other end of the levers *h*, *h'*. The steam is admitted into the cylinder, for the purpose of actuating the piston, in the following manner:—It will be seen, by referring to fig. 2, that the end *b'*, of the shaft is made hollow, having a midfeather *i*, through the centre, to divide the entrance-pipe *k*, from the exit-pipe *l*, and revolves in a hollow steam-chest or chamber *m*, being packed steam-tight by means of stuffing boxes. Steam is introduced into this chamber by the feed-pipe *n*, and passes through the opening *o*, into the entrance-pipe *k*, and thence through the slide-valve (which is of the ordinary construction) to the steam cylinder. The action of the piston communicates rotary motion by means of the connecting-rod *e*, and the crank *f*, to the crank-shaft *g*; upon one end of this crank-shaft *g*, the planet-wheel *p*, is keyed, gearing into a sun-wheel *q*, of the same diameter; this wheel *q*, has no motion whatever, but merely serves as a rack, around which the planet-wheel *p*, travels. Through the boss of the wheel, *q*, the end *b*, of the main driving-shaft passes, revolving loosely. Thus it will be evident, that, in consequence of the wheel *q*, remaining perfectly stationary, the rotation of the crank-shaft *g*, will cause the planet-wheel *p*, to travel round the sun-wheel or circular rack *q*, in the same space of time in which it revolves upon its own axis, thus causing the engine to revolve, while going through its reciprocating action; the main-shaft *b*, *b'*, being the fulcrum, and revolving with it, in consequence of the bosses of the levers *h*, *h'*, being keyed fast upon that shaft. In this improved arrangement of the steam-engine, in order to work the slide-valve, the excentric *r*, is stationary, and is connected to the valve by a series of links and levers *s*, *s*, *s*; the rotation of the engine communicating the requisite motion to the valve, the same as the revolution of the excentric *r* would do if the engine were fixed or stationary. Fig. 3 is a face view and section of a cam, to be used in connection with this arrangement, in place of the excentric, if it is desired to work the engine expansively; this cam being calculated to cut off the steam at half stroke.

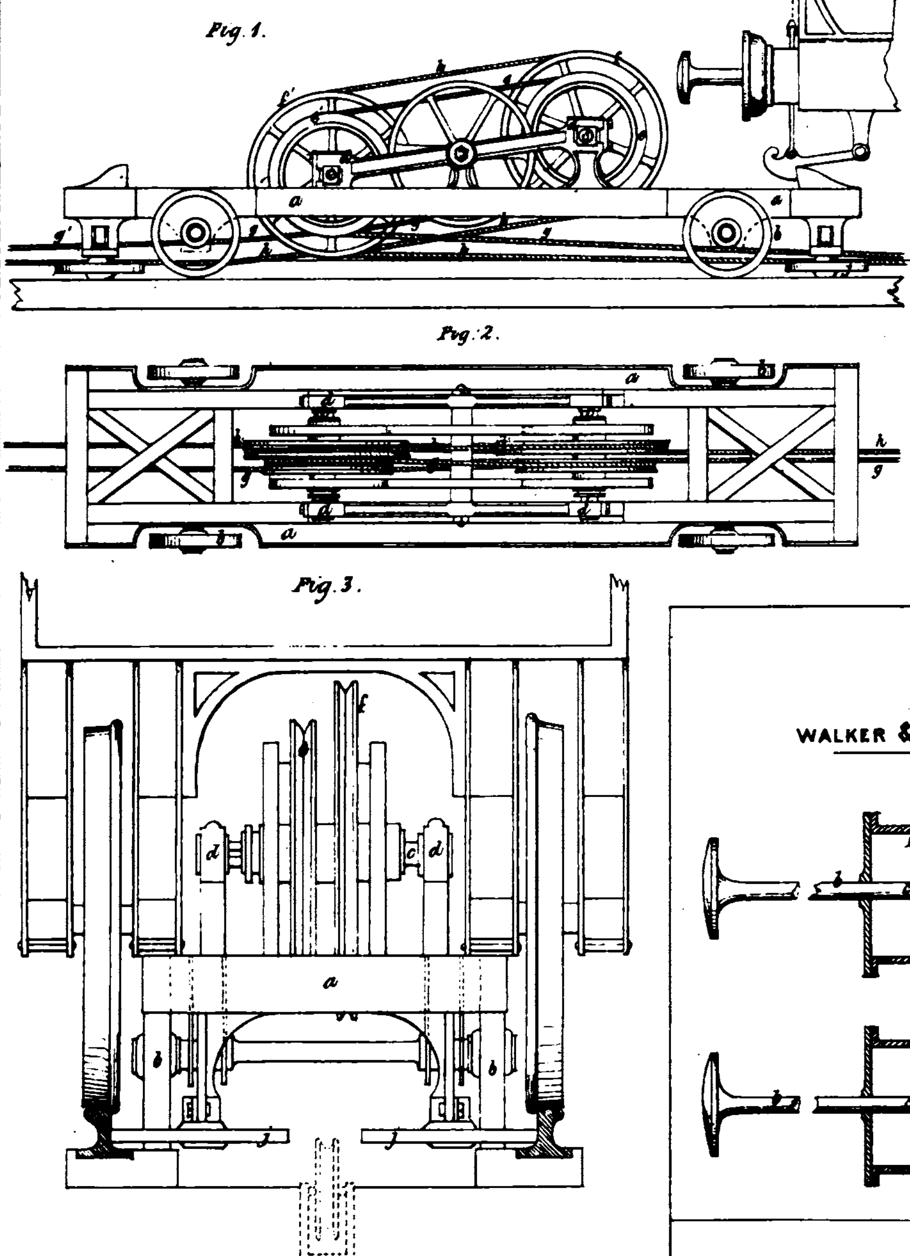
The patentee remarks, that he has represented his invention as applied to a high-pressure "stationary" steam engine; but he considers the improved "planetary engine" equally adapted to condensing engines, and whether employed for marine or other purposes.

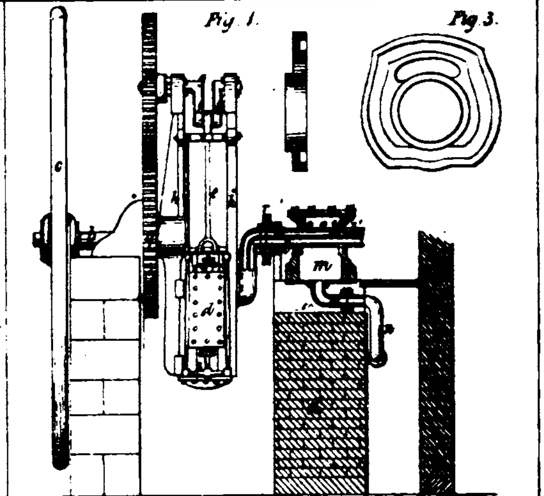
MANUFACTURE OF GAS.

James Murdoch, of Staple-inn, Middlesex, mechanical draughtsman, for "*certain improvements in the manufacture of gas, and in the apparatus employed therein.*—(Being a communication.)—Granted February 20th; Enrolled August 20th, 1845; with engravings. Plate III.

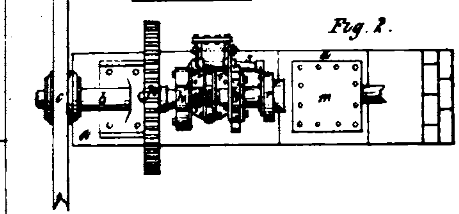
This invention consists in certain improvements in the manufacture of gas for illumination, which are effected by means of an apparatus shown in the engraving. fig. 1, is a transverse section, and fig. 2, a longitudinal section thereof. *a*, is for the coal. The neck *a'*, of the retort is connected by a horizontal tube with a vertical retort *b*, at the back of the apparatus; and this retort *b*, is connected by another horizontal tube *c*, parallel to the first, with the neck *d*, from whence a pipe *e*, extends to the cooling apparatus *f*: the two horizontal tubes are termed purifying retorts; and each contains a spiral piece of iron. The retort *b*, is nearly filled with coke or charcoal, and is usep for decomposing water, supplied through the syphon-pipe *g*, which descends nearly to the bottom of the retort, as indicated by the dotted lines in fig 2. The lid of the cooling apparatus *f*, has, on its under side, a long spiral channel, interrupted by stops, so as to cause the gas, admitted into the apparatus by the pipe *e*, to pass over a large surface of water, and occasionally through it, previous to its escape through the pipe *h*, to the gasometer. *i*, is a syphon-pipe, for carrying off the surplus water of the cooling apparatus. *l*, *l*, are fire-bricks to protect the retort *a*, from the direct action of the flame; and *m*, *m*, are openings, conducting the

GALLOWAY'S RAILWAY PROPELLER

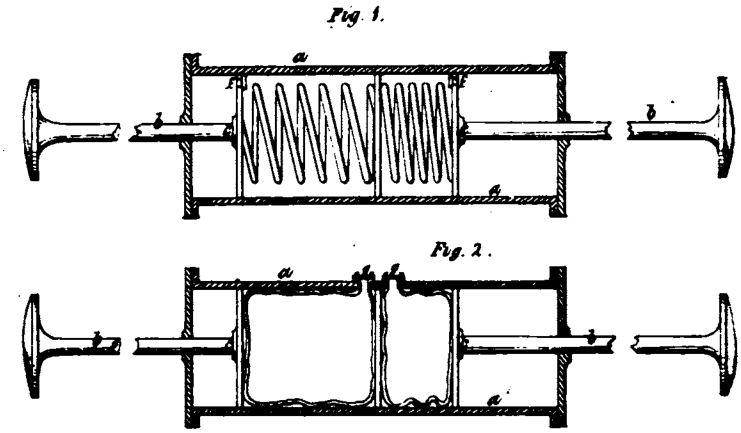




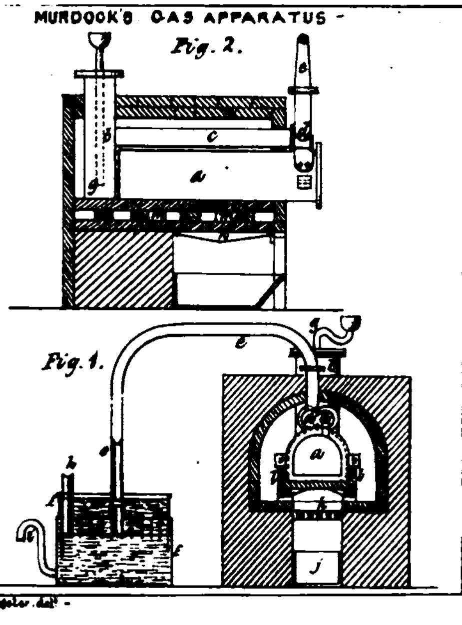
RAWORTH'S STEAM-ENGINE



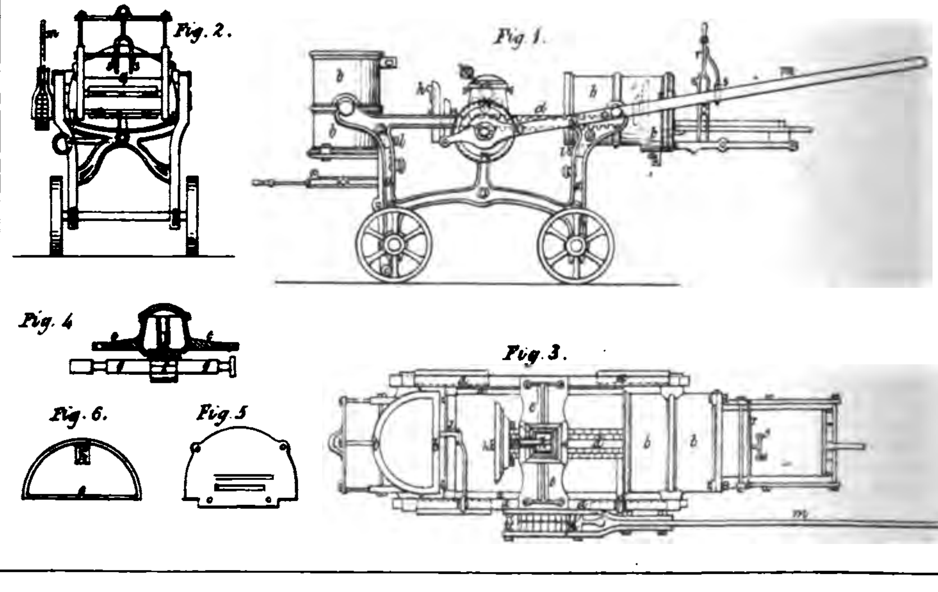
WALKER & MILLS'S RAILWAY BUFFER



MURDOCK'S GAS APPARATUS



WELLER'S BRICK MACHINE



C. Bagley del.

flames to each side of the retorts, and heating them by reflection from the roof *n*, of the furnace, composed of fire-brick. *j*, is a vessel containing water, to protect the fire-bars *k*, from the destructive action of the fire, and by the steam arising therefrom to increase the combustion of the fuel.

The mode of working with this apparatus is as follows:—The covers of the purifying retorts are first secured and carefully luted; the retort *b*, is nearly filled with coke or charcoal, and its cover secured and luted; a fire is then lighted in the furnace, to bring the retort *a*, and purifying retorts to a cherry-red heat, and the water retort *b*, to a bright red heat; and when this heat is attained, the retort *a*, is charged with coal, and water is admitted, in small quantities, into the retort *b*. The action of the heat upon the coal disengages gas mixed with tar, which passes into the first purifying retort, and the sulphuretted hydrogen contained therein is decomposed by the coil of incandescent iron; at the same time the tar undergoing a second distillation is converted into gas, and mixes with that coming direct from the coal. The gas, which is now more dense from its combination with the carbon contained in the tar, proceeds along the purifying retort, until it arrives at the retort *b*, where it mixes with the hydrogen resulting from the decomposition of the water by the incandescent coke or charcoal, and passes into the second purifying retort, *c*, carrying with it the carburetted vapours and volatile oils which may have escaped decomposition, but which, in their course along the retort *c*, become decomposed by the heated coil of iron, and give out their carbon to the hydrogen. By this means the hydrogen becomes carburetted without impoverishing the other gas. The gas then proceeds through the pipe *e*, to the cooling apparatus *f*, and thence through the pipe *h*, to the gasometer. Instead of coal, resins, schistus, oils, fats, and similar substances, may be distilled in this apparatus; and, provided the purifying retorts, with the coils of iron, are retained, the gas may be distilled and purified at one operation, without the employment of a water retort.

MANUFACTURE OF TILES.

Richard Weller, of Capel, near Dorking, Brick and Tile manufacturer, for "*Improvements in the manufacture of drain and other tiles and pipes.*"—Granted March 27, 1845; Enrolled Sept. 27, 1845.—(*With an Engraving.*)—*Reported in the Repertory.*

We gave a brief description of this invention last Dec., which for want of drawings was not properly understood, we now give another description, with reference to the drawings, which will make the invention intelligible. The invention consists of improvements in arranging and constructing machinery for facilitating the making of drain, and other tiles and pipes.

Description of the Drawing.—Fig. 1, is a side view of a machine, constructed and arranged according to this invention. Fig. 2, is an end view; and, Fig. 3, is a plan of the machine; and the other figures of the drawing show details; and in all the figures, the same letters are used to indicate the same parts of the machinery. *a*, *a*, is the framing of the machine, the nature of which will readily be traced on examining the various figures of the drawings. The machine is mounted on four wheels, to facilitate the transport thereof from place to place. *b*, *b*, are two vessels, within which work pistons, for expressing the clay through dies or moulding orifices at the outer ends of the vessels, *b*, *b*, and the machinery is so arranged, that when one of the vessels *b*, is having the clay expressed therefrom through the moulding orifice or die, affixed thereto, the other vessel, *b*, is brought into a position for allowing the same to be filled with clay. The vessels, *b*, are of a cylindrical form at their upper parts, and flat at the under parts, which will be found to be a very convenient form, particularly when making half cylinders, or bent tiles of large diameter, compared with the diameter of the vessels, *b*; and, although it is believed that it is better to have somewhat more than half a cylinder as shown, yet the shape may be varied, so long as the sectional figure of the vessels *b*, be composed of a curve and a straight or horizontal line. The vessels *b*, *b*, are mounted on necks or trunnions, so that they may move in bearings, in such manner as to assume at one time a horizontal, and at another, a vertical position, by which, when either of the vessels *b*, has been emptied by its piston or plunger, it may be turned in a position to be again filled. *c*, *c*, are the two pistons or plungers, which respectively work in the two vessels *b*, *b*. These pistons are fixed to the two ends of the bar, *d*, which is supported, and slides in a suitable bearing in the bridge, *e*. On the under surface of the bar, *d*, is formed or affixed a toothed rack, which is worked by means of the pinion, *f*, on the axis, *g*, such axis receiving motion, by means af a lever hereafter described. In each of the pistons is an opening, over which is placed a flap or valve, *h*, which allows of the air passing between the piston and the clay, when the piston is drawn back, and thus is the drawing back of the piston facilitated. On the upper surface of the bar, *d*, are formed four rows of ratchet teeth, two rows being formed so as to receive the catches or stops, *i*, which will retain the band from going back in one direction, the other two rows of teeth being formed or cut in an opposite direction, so as to receive the two catches or stops, *j*, to retain the bar, *d*, from moving back when working in the other direction; and the object of thus stopping the bar, *d*, is, that the piston which is in work, may not be driven back by the air which may have been compressed between the piston and the clay, when the lever, *m*, is put back, in order to make another stroke. The two sets of catches or stops, *i*, *j*, are connected together as shown, so that, by moving the lever, *k*, those stops or catches which have been in action are moved out of action, and those which are out of action, are brought into action. By this arrangement the bar will be held from returning, in whichever way it may be working; and when the piston at the end of the bar, *d*, has been forced up to the end of its stroke, the lever, *k*, is reversed, which will change the positions of the catches or stops, *i* and *j*, and then the bar, *d*, may be reversed in its direction of movement, which will, by the other piston, force out the clay from the other vessel, *b*, and allow the vessel, *b*, which has just been emptied, to be moved in its axis or trunnions, so as to assume a vertical position, in order again to be filled with clay. *l*, *l*, are catches which retain the vessels, *b*, in the horizontal or in the vertical position. It may be remarked, that although the vessels, *b*, *b*, are preferred when mounted on axes to be of the form shown and described, yet this part of my invention is equally applicable to vessels of a cylindrical or other shape, from which clay is forced by pistons or plungers, through moulding orifices, or dies, to make tiles or pipes; for such vessels may, with equal advantage, be mounted on axes or trunnions. The moulding orifices are formed in the said covers of the vessels, *b*, and are as heretofore, suitable for making tiles of different forms or pipes, and are well understood, and therefore do not require to be described in this specification. The bar, *d*, is moved to and fro by means of the lever, *m*, which gives motion to the axis, *f*, first in one direction, then in the other, in the following manner:—*n*, is a ratchet-wheel fixed on the axis, *f*: this ratchet wheel has two sets of teeth cut in opposite directions, and the lever, *m*, (the nature of which is clearly shown in the drawing,) has the drivers *o*, *p*, so that when the lever-handle, *m*, is on one side the axis, it will, on being raised and lowered, cause the wheel, *n*, and consequently the axis, *f*, to move round, which action will be continued till the piston (in action) has completed its stroke, when the small lever, *k*, is to be moved over, which will reverse the stops or catches, when the lever, *m*, may be moved over to the other side of the axis, *f*, when the working of the lever, *m*, up and down, will cause the axis, *f*, to be moved in the opposite direction, and by the other piston, it will force out the clay from the other vessel, *b*, allowing time for the empty vessel, *b*, to be filled again with clay. The tiles, as they are forced out, are received on suitable "horses" as heretofore; and they are cut off by means of the wires, *q*, carried by the sliding frame, *r*; and when the tiles are to be punched with holes, such as flat tiles for roofing purposes, a suitable punch is applied, *s*, to the frame, *r*, so that in causing the frame to descend, a tile will be cut off, and punched at the same time.

MISCELLANEA.

An interesting experiment took place at Portsmouth on the 13th Jan off the Excellent, Captain Chads, on the most speedy and efficacious mode of destroying a boom, which might impede the progress of boat squadrons in narrow rivers, as in the case of the recent attack on the pirates of Borneo by the squadron under Rear-Admiral Sir Thomas Cochrane. The first experiment took place on the 9th, but was on a smaller scale than the present, consequently was not so convincing or successful in its results. On the present occasion two line-of-battle ships' lower masts were taken from the old mast pond and moored at a short distance from the Excellent. Six turns of small chain lashing secured the two spars in the centre; the ends of the spars were secured by two half hitches of chain, and two parts of the chain cable ran along the spars, and were secured in the same manner round the opposite extreme. The spars being thus secured, as if at the entrance of a river or creek, to prevent intrusion, the operations now commenced to dislodge them:—A breaker, containing 56lb. of gunpowder, was brought to the spot; at one end were eight inches of port-fire passed into it, over which was secured a copper tube made perfectly water tight, and two threads of quick match being attached to the upper end of the port-fire, and the opposite extreme brought through to the mouth of the tube above the water, they were ignited, and the breaker being thereupon hauled and secured immediately under the spars, a sufficiency of time (eight minutes) was provided for the boat to get clear of the mass before the port-fire reached the powder, which it did in the time above mentioned, when a tremendous explosion took place. On examining the spars and their fastenings afterwards, the following was the result:—14 feet out of the centre of both spars were shivered into atoms, with one of the chain lashings blown up with the timbers. The same experiment was afterwards repeated upon the shorter end of the obstruction, under the parts of the chain cable, the result of which was that the whole of the spars was blown to pieces. These experiments were highly successful and satisfactory. On the following morning a further experiment was made upon the two long ends of the same spars, with the chain cable wound round them, and a hemp (13-inch) cable hove "taut" in the intervals, the rest of the arrangements being the same as yesterday, except the quantity of powder, 112lb. being used to-day. The result was the total demolition of both spars, the chain cable was thrown to the bottom, and the hempen one blown away. Thus the success of the experiments is most unqualified and important. They were performed at the desire of Lord Ellenborough, who had expressed to Captain Chads, in a letter, his opinion upon the importance of naval officers becoming acquainted with the safest and most speedy method of removing such obstructions as those offered to the China squadron on the late occasion of the conflict with the pirates in the Malvado river. Captain Chads personally superintended the operations of the respective experiments, and which were executed by Lieutenant Robert Jenner, gunnery lieutenant to the Excellent, in a manner highly creditable to the talents and ingenuity of that officer.

Difference of Time.—In the streets of Brussels there may now be seen in the windows of the clockmakers' shops large mahogany clocks with the following inscription, "Railway time." It appears that it is owing to the care of the directors that these clocks have been exposed, in order to facilitate the arrival of travellers at the different times of departure.—"*L'Observateur.*"

An American Manufacturing City.—The ten manufacturing companies of *Lowell* consume annually 12,000 tons of coal, 3,070 cards of wood, 72,549 gallons of sperm, and 19,000 of other oil. Of the whole population of Lowell, 6,320 females, and 2,915 males, together 9,235, are employed as operatives, either in the mills or connected with other mechanical employments. There are 33 mills and about 550 houses belonging to the corporations. The capital invested in manufacturing and mechanical enterprises is 12,000,000 dollars. There are made in Lowell every week 1,459,150 yards of cloth, or 75,868,000 yards per year. The cotton worked up every year is 61,100 bales. The printed calicoes made annually amount to 14,000,000 yards, the payment annually amounts to more than 1,500,000 dollars, and the annual profit of this immense business has been estimated at the same amount, or at about 12½ per cent.—"Globe."

The Amphion Frigate.—This frigate of 36 guns was launched at Woolwich on the 14th January. The building commenced on the 5th of April, 1830; she has since been lengthened 16 feet by the bow, and fitted in the stern for a screw-propeller as an auxiliary, every other part and fitting being the same as a proper sailing frigate. She appears to be a sightly vessel, and sits well upon the water. Her figure head is a bust of the late gallant Captain Sir William Hoste, Bart., and her stern is of a neat square form externally, but round internally, for fighting her guns. To all appearance she will be a fast sailer, and a good ship of war. The following are her dimensions:—

	Feet.	In.
Length of the lower deck	177	0
.. .. keel for tonnage	152	5¼
Breadth extreme	48	2
.. For tonnage..	42	8
.. moulded	42	0
Depth in hold	13	4½
Burden in tons, old measure, ...	1473 66-94ths.	
.. .. new	978 141-3500ths.	

The Amphion is fitted with engines of 300-horse power by Messrs. Miller, Ravenhill and Co., and will be the first constructed for the steam navy of this country with the whole of her machinery considerably under the water line, and consequently not liable to be deranged by shot. The screw will be 15 feet in diameter, on Ericson's principle, attached to engines on the direct action principle, with four-feet stroke, performing 48 revolutions per minute. The boilers will also be under the water line, and the vessel is expected to be a superior ship of war by the aid of these appliances.

Valuable Discovery.—A French mechanic formed the idea that by subjecting iron-dross to the slow cooling process which is known to produce a total change in the nature of glass, a new and useful species of stone might be obtained; and as iron dross, such as the large furnaces yield, is a wholly useless substance, the announced successful result of his persevering attempts cannot but be matter of great interest, more especially at the present time, when the smelting furnaces of England are in a hitherto unknown state of activity. The object which the Frenchman sought to accomplish was, to impart to iron-dross the compactness and hardness of granite, and, at the same time, to save the cost and labour which the hewing of the real stone requires. To this end he contrived to let the iron refuse, while in a fluid state, run into iron forms, which were previously brought to a red heat by being placed so as to receive the superfluous flame which issues from the mouth of the furnace; and in order to ensure the slow cooling, these forms are provided with double slides, between which sand is introduced, which is well known to be a bad conductor of heat; the whole is then brought again to a glow heat, and in like manner again cooled off. By this procedure, it is asserted, the ingenious discoverer has succeeded in forming paving-stones, flags, large building-blocks, and even pipes, of any given form, of a degree of hardness and polish equal, if not superior to the best hewn natural granite, and at the most trifling conceivable cost.

The Manufacture of Steel in Spain.—The following particulars, respecting the fabrication of cast-steel and Damascus steel, at the forges of Toledo, in Spain, may perhaps be deemed interesting. It has been found that ovens do not produce a sufficient heat to melt the steel, consequently they have been obliged to construct forges, and the metal is placed in crucibles of earthenware, that withstand the greatest fire. The first process is by mixing the oxydes and filings of iron in a crucible, which is placed in the forge, heated by charcoal and continued with coke. The crucible is kept about half an hour in the fire, so as to become a clear red heat, after which it is exposed to the air to cool. Then comes a second fusion, by taking 100 parts of this crystallised matter, and mixing it with 100 parts of iron filings, which, after being exposed to the fire for one hour and a half, a very pure metal is obtained for forging. The forging of the melted metal must be done with great caution, and at a degree of heat far below bright red. When it has acquired the temper necessary, it is reduced to one quarter its size by the means of heavy hammers, and formed into bars; after which it is filed at each end, so as to ascertain if it is of good and pure quality, and the variegated stripes can be given at pleasure. It is re-heated, and tempered at dark red heat, and rubbed with wax, which evaporates. It is afterwards polished with pummice stone, and, to ascertain that it is free from grease, it is emerged in pure water, which adheres to its surface; it is then dipped in acidulated water, and covered, after being well dried, with oil for a day. The fabrication of Damascus steel is by placing three lines of cast-steel one upon the other, and heating them together, so as to form but one blade. The composition is 6lb. of soft iron, 150 grammes of wolfram, and 144 ditto of carbonate of manganese, which makes 2lb. of fine Damascus steel; pulverised nickel is also used, but it must be pure and free from arsenic—the best nickel is that received from Germany. In giving the steel the different colours, it is cleaned of all grease, and emerged in distilled water, mixed with oxalic acid, which causes the various veins in the steel to appear. The working of steel, is one of the greatest branches of Spanish commerce in the iron mining districts which abound in wood and coal.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM DECEMBER 22, 1845, TO JANUARY 27, 1846

Six Months allowed for Enrolment, unless otherwise expressed.

Henry Pershouse, of Birmingham, manufacturer, for "a certain improvement or certain improvements in apparatus used in connection with writing, and also in attaching postage stamps and labels."—Sealed December 22.

John Pain, of Greenwich, in the county of Kent, engineer, William Hartree, of Greenwich, lace-maker, engineer, and John Matthew, the younger, of the same place, engineer, for "certain Improvements in steam engines and machinery for propelling vessels which improvements are also applicable for other purposes."—December 23.

William Cole, of Coventry, warehouseman, for "certain Improvements in looms."—December 23.

John Dearman Dunnicliffe, of Nottingham, lace manufacturer, and William Bull Dexter, of the same place, lacker, for "Improvements in the manufacture of warp fabrics."—December 24.

Daniel Towers Shears, of Bank Side, Southwark, for "Improvements in the treatment of zinc ore for the purpose of producing zinc ingots, which improvements are applicable to the reduction of other ores and metal." (A communication.)—December 24.

Charles William Siemens, of Finsbury Square, in the county of Middlesex, engineer, for "Improvements in steam engines, and improvements in regulating the power and velocity of machines for communicating power."—December 24.

Wilton George Turner, of Gateshead, in the county of Durham, doctor in philosophy, for "an Improved mode of treating guano for the purpose of obtaining chemical compounds therefrom."—December 24.

John Russell, of the City of Edinburgh, accountant, for "a manufacture of glass tiles."—December 30, 1845.

Thomas Swinborne, of Lincoln's-inn, Esq., for "Improvements in railways and in the means of propelling and carrying thereon."—January 3, 1846.

Arthur Eldred Walker, of Bouverie-street, London, engraver, for certain ["Improvements in machinery for sewing."—January 6.

Conrad Haverkam Greenhow, of North Shields, gentleman, for "Improvements in the construction of railways and railway carriages."—January 6.

Henry Watson, of Newcastle-upon-Tyne, brass-founder, for "Improvements in withdrawing air and vapours from furnaces, or other apparatus, and in condensing and employing such vapours."—January 6.

Joseph Romnald Boxek, of Cheapside, mechanic, for "Improvements in the construction and application of railroad carriage-wheels."—January 6.

William Smith Brown, the younger, of Broad-street, Ratcliffe-cross, sail-maker, for "Improvements in the manufacture of square and quadrilateral sails, for ships and other vessels."—January 6.

Joseph Douglas, of Cross Cheaping, Coventry, furnishing ironmonger, for "improvements in the patterns used for casting and in casting metals."—January 9.

Charles Chinnock, of Cook's-grounds, Chelsea, for "Improvements in the construction and methods of extending and compressing articles of furniture and domestic use, also applicable to cutlery, workmen's tools, windows, blinds, shutters, and similar useful purposes."—January 12.

Charles Hancock, of Grosvenor-place, gentleman, for "certain Improvements in the manufacture of gutta percha, and its application alone, and in combination with other substances."—January 12.

Henry Schloss, of Finsbury-square, gentleman, for an "Improved instrument, or instruments for producing ignition."—January 12.

John Seaward, of the Canal Iron-works, engineer, for "Improvements in the steam-engine, and in machinery for propelling."—January 12.

George Tillett, of Snow-hill, Ironmonger, for "Improvements in stoves and fireplaces."—January 13.

Jean Marie Durnerin, of Paris, Doctor of Medicine, for "Improvements in treating fatty matters."—January 13.

Thomas Moorcroft Benbow, of Birmingham, surgeon, for "Improvements in fastenings for surgical and other bandages, and for articles of dress."—January 13.

Robert Bewick Longridge, of the Bedlington Iron-works, near Morpeth, Northumberland, for an "Improved locomotive engine."—January 13.

Joseph Maudslay, of the firm of Maudslay and Field, of Lambeth, engineers, for "Improvements in propelling and propelling machinery."—January 13.

Edmund Leahy, of Cork, Ireland, Civil Engineer, for "Improvements in locomotive carriages, intended to be employed on ordinary roads."—January 15.

William Benson, of Allerwash House, Haydon-bridge, Northumberland, gentleman, for certain "Improvements in machines for the manufacture of tiles and other plastic substances."—January 15.

William Clark of Nottingham, and William Vickers the younger, of the same place, lace manufacturers, for "Improvements in manufacturing lace and other fabrics by lace machinery."—January 17.

Arthur Wellington Price, of Manchester-street, Gray's-inn-road, gentleman, for "Improvements in the construction of anchors."—January 17.

Peter Taylor, of Hollingwood, near Manchester, machinist, for "certain Improvements in machinery for propelling vessels, carriages, and machinery, parts of which improvements are applicable to drawing and propelling fluids, also improvements in the construction of vessels.—January 20.

Gerard Andrew Arney, of Mare-street, Hackney, gentleman, for "Improvements in the preparation of gelatine, and improvements in fining or clarifying liquids.—January 20.

John Braithwaite, of Bedford-Square, Civil Engineer, for "Improvements in heating, lighting, and ventilating.—January 20.

William Vincent Wennington, of Goscote Iron works, Stafford, esquire, for certain "Improvements in, or improved methods of cutting plate and sheet iron.—January 20.

Richard Archibald Brooman, of Fleet-street, London, gentleman, for certain "Improvements in railway and common road carriages. (A communication.)—January 20.

William Malins, of Mansion House-place, London, and West Bromwich, Stafford Iron Master, for certain "Improvements in the construction of buildings.—January 20 (A communication.)

William Newton, of Chancery-lane, Middlesex, Civil Engineer, for certain "Improvements in manufacturing piled fabrics.—January 20. (A communication.)

John Nott, of the city of Cork, gentleman, for certain "Improvements in the means of communicating intelligence from one place to another.—January 20.

William Henry Burke, of Tottenham, gentleman, for certain "Improvements in the manufacture of fabrics which may, if required, be made air and waterproof; a part of the materials employed herein, when combined with other matters, being intended to produce coverings for vessels of capacity.—January 20.

Andrew Kurtz, of St. Helen's, Lancaster, manufacturing chemist, for certain improvements in the construction of furnaces, and apparatus connected therewith, for evaporating or concentrating sulphuric acid."—January 20.

John Spenceley, of Whitstable, in the county of Kent, Master Blockmaker, for "Improvements in the construction of ships and other vessels, and also improvements in apparatus to be attached to ships and other vessels."—January 20.

John Walker, of Manchester, silk manufacturer, for certain "Improvements in weaving or manufacturing piled or napped cloths or fabrics, and also improvements in machinery or apparatus for cutting the pile or nap of the same."—January 20.

Charles Wheeler, of Speenhamland, Berkshire, machinist, for "certain improvements in the construction and working of railways."—January 22.

Joseph Cooper, of Great Chart-street, Hoxton, chemist, for "an improved mode of separating certain of the fluid, and soluble parts of certain vegetable substances from the solid parts thereof."—January 22.

Frederick William Campin, of Fleet-street, in the City of London, gentleman, for "certain improvements in obtaining and applying motive power."—January 22.

Daniel Ross, of South-street, Southwark, hat manufacturer, for "Improvements in the manufacture of hats."—January 27.

CORRESPONDENTS.

The appearance of Mr. Bashforth's letter prevents us from inserting a very ingenious paper on atmospheric traction, received in the earlier part of the month.

ERRATA.

In speaking of the plate of the engines of the Great Britain, in our last number, p. 9, we were made to say that the engraving was "not sufficiently explanatory," the word "not" should have been omitted.

In the notice of the Model of the Parthenon, in the present number, p. 44, col. 2, the first note belongs to Mr. Lucas's book; the second is editorial; the word "cella" is misprinted "cellar."

IDEA FOR THE FACADE OF THE BRITISH MUSEUM.

(With an Engraving, Plate IV.)

Little less than marvellous is it—certainly unaccountable, that so important a structure as the British Museum—the most public of all our public edifices, because that to which the public have freest access, should be regarded by the public and the public press with so much apathy and indifference. Or if it is not to be attributed to sheer indifference, the sullen silence which has succeeded to the bitter remonstrances made against the design for the Façade at the time the works for it were first commenced, argues despair. and the unhappy conviction that all the remonstrances in the world would have no effect upon those whom it has behoved to consider very seriously what they are about, and to reconsider the design adopted for the Façade, ere it be altogether too late. Poor as it would be, it would still be some sort of satisfaction to be informed what it is that has recommended the design in question, what are the particular merits and beauties discerned in it, and claimed for it. Instead of which, all that has been said about the intended Façade has been strongly AGAINST it, without the slightest attempt having been made to reconcile us to it, by gainsaying any one of the objections which have been urged in condemnation of it. If they can fairly be set aside, the neglecting to do so looks much more like scornful disregard of public opinion, than like generous forbearance. However matters of the kind may have been managed formerly, at the present day, we have some right to expect to be tolerably well satisfied beforehand that a work of such magnitude and importance, will be found perfectly satisfactory when completed.

To bid us wait—to suspend our judgment until we shall have the entire Façade before us, is merely idle evasion, for the Model might all along have been exhibited for general inspection in the Museum itself, instead of being kept there under lock and key, jealously secluded from all eyes but those of a privileged few,—eyes likely to be far more partial and indulgent, than at all critical. Does such very cautious *vigilance* bespeak comfortable confidence—well-grounded assurance that the model justifies what was on one occasion said of the design?—but said, be it remarked, very long ago, when the name of its architect stood very much higher in general estimation than it does at present; and that, not because he himself has fallen off from what he once was—on the contrary, he remains just the same as he always was *ab initio*,—but because others have far outstripped him, and because several structures have in the interim arisen both in this and other countries, in comparison with which the British Museum will show exceedingly poor,—rescued from insignificance only by its mere magnitude as a building, and on that very account all the more distressingly unsatisfactory, because the occasion both demanded, and afforded opportunity for something infinitely superior. For that to be merely passable, which ought to be a *first-rate* piece of architecture of its kind, and to display all the very best qualities of the style adopted for it, amounts to nothing less than failure. We are annoyed by the disagreeable contrast which impresses itself upon us, between the what *is* and the what *might have been, and ought to have been.*

In the case of the British Museum, those who will have to answer for the disappointment which the building will create, will have left themselves very little excuse for their error. They will in a manner have made themselves doubly responsible by waiving off all interference whatever in the shape of opinion, remonstrance, or the expression of wish that the building should prove at least not inferior to other contemporary ones, in the same or a similar style. Interference of that kind being totally disregarded, all the less scrupulous need we be about speaking out quite freely, being well assured that our remarks will not in the slighest degree disturb or perplex either the architect himself, or those who sanction his treatment of the British Museum façade.

There is no necessity for waiting longer when the whole already exhibits itself very clearly to an architectural eye, the entire mass being shaped out, and as much of it completed as very distinctly shows the precise quality of the architecture, and the degree of finish and effect. There is nothing at all doubtful,—nothing left for conjecture: we cannot flatter ourselves with the possibility of being mistaken in regard to any of the architect's intentions, or with the hope of being taken very agreeably by surprise by aught that yet remains to be done. Even yet, indeed, there remains an opportunity for redeeming the Façade by introducing into it a magnificent feature that should be superior to every thing which we now have of the same kind. We are not therefore exactly too late, though certainly not at all premature in submitting an idea of our own; though its being in sufficient time to allow of its being adopted, makes, we are fully aware, no difference whatever. By some, perhaps, it would be considered better timed, were it to be kept back until the possibility of adopting it, had altogether passed away. We of course lay ourselves open to the charge of presumption in pretending to *correct* the architect's design, more especially as it is one in regard to which the Horatian precept of *Nonum prematur in annum* has been observed in more than its fullest extent. Let us be deemed ever so presumptuous, we will not show ourselves sneaking also, by gently protesting that we feel exceedingly doubtful whether our variation would be any improvement after all,—that we here produce it most hesitatingly, and reluctantly,—with many other pretty perjuries of the kind, which if Jupiter does not laugh at them, all sensible readers will at once see through. All that we have to observe apologetically is that the accompanying Elevation (see Engraving) purports to be not such a design as we could have wished to see adopted, but merely an alteration of the existing one, adapted to the Façade as already shaped out, so as not at all to disturb the structure itself, or in any way interfere with what is actually done, except in so slight a degree as to be of no moment.

Nothing more would be required than to enlarge the plan of the centre portico, making it of a different order and upon a larger scale than the colonnades along the rest of the façade, whereas now that portico will be merely in continuation of them, and not otherwise distinguished in the general mass than by the addition of a pediment—very insufficient to give a decided expression of loftiness to the centre of the composition. For the colonnades alone, as subordinate to the main feature, the present Ionic order may be upon a sufficient scale, but it will not produce a portico upon a scale at all more majestic than some which we already possess—not comparable in that respect—or indeed, any other—with that of the Royal Exchange. Projecting only a single intercolumn in advance of the lateral colonnades, it will not display itself at all advantageously, neither will it be of sufficient depth within to be attended with much architectural effect on that account, or properly to answer the purpose of a *Vorhalle*, or open colonnaded vestibule containing the entrance to the building, because it will be in a manner choked up with a second row of columns within corresponding with those in front, and dividing it into two spaces not at all wider than the other colonnades. Great advocates as we are for the use of internal columns in porticos, we are far from approving of the arrangement of them in the portico that is to be, of the British Museum. A certain degree of richness will, no doubt, be so produced, but, it may be apprehended, it will cause the rest of the colonnading to look meagre and scanty, by comparison, especially at the external angles,—where we could wish to have seen square pillars, if only in order to break the monotony arising from such a number of columns as there will be, and nothing else. The whole façade will consist of nothing more than columniation put up in front of a fenestrated structure. Take away the former, and so far from losing any thing essential to it, the rest would remain as good as ever, without there being aught to show that there had been columns, or that the structure was framed with reference to their becoming constituent parts of it. Were they taken away, there would be no hiatusses on the design; it would be only rendered astylar, with a single range of windows, not very dissimilar from the Hall of Commerce in Threadneedle Street, except that it would be somewhat less ornate. Over-decoration will certainly not be the failing of the façade of the British Museum: the absence of sculpture and all other artistic embellishment may obtain for it the reputation of simplicity from those who have no have no other idea of simplicity than that of nudity and bareness; yet the inscription of "British Museum" will be necessary to apprise strangers that within such structure may be found some of the most precious remains of ancient art and sculpture, and the model of the Parthenon, to boot. Even the order itself is nowise distinguished: it is a fair average example of Grecian Ionic, and nothing more, and except that the shafts of the columns are fluted, it is quite plain. It is in fact the same example as that employed for the Post-office, without any attempt at difference of character and expression. Its merit therefore is merely of a mechanical kind, for it has not cost the architect the exertion of a single fresh idea. What will serve for a Post-Office, will serve, it seems, equally well for a Museum; although there had need be something more than usually striking in the order to make amends for the tameness and monotony of the general design.

In our altered version of the Elevation, the Ionic order becomes a secondary one, and as such contributes to contrast with and set off the Corinthian octastyle, which though considerably loftier (being somewhat higher than the portico of the Royal Exchange) would not in its turn have the effect of diminishing the other columns by comparison, the latter being on quite as large a scale as we are accustomed to. By exceeding that scale, and rising up higher than the Ionic colonnades, the central portico would confer dignity on the whole façade. That such combination of two different orders is not in strict accordance with Grecian precedent, is what we need not be told; yet it seems to us that, instead of requiring excuse, such deviation from the letter of Greek architectural law, would rather tend to excuse those violations of it which there will now be, by proclaiming at once that the building does not affect to be severely Grecian.

The Plan accompanying the Elevation, shows the Corinthian octastyle to be brought forward two intercolumns in advance of the adjoining colonnades; owing to which it would be rendered unusually spacious, and would constitute a rather striking piece of architecture internally; while another advantage would be that the portico would display itself more prominently in an oblique view of the façade. In the external elevation of our Corinthian Portico, there is nothing either amounting to design, the sketch merely indicating the order and showing that the frieze of the entablature, and the pediment would be enriched with sculpture. But perhaps some little degree of novelty may be claimed for the mode in which the portico is connected with the lateral colonnades, which latter are entered through open doorways or portals, answering to the extreme intercolumns of the octastyle. Thus treated the portico would be better enclosed than if open at its ends, into the colonnades, and a greater variety of effect upon the whole would be produced. One other thing that may deserve to be pointed out as partaking of novelty, is the position of the two statues against each of the extreme columns of the octastyle, in which situation such figures would, we conceive, tell very forcibly, and throw a good deal of play into the architecture.

We are aware that such a portico as we have imagined could not be applied to the building in its present state: it would be necessary to carry up the back wall of the portico higher, and also to raise the centre of the roof to the pitch of the loftier pediment. What then? there would be nothing of very awful or unheard of extravagance in doing that; far better that, than to erect what may some time hence be doomed to be taken down again to make room for something more dignified. If Sir John Soane built the exterior of his Law Courts twice over;—if the wings that were first put to Buckingham Palace were no sooner up than they were taken down again, the mere consideration of a little more expense and a little more delay, ought not to deter from effecting even at the eleventh hour an alteration greatly for the better in the façade of the British Museum. That we ourselves consider it would be one greatly for the better is evident; and most persons we fancy, will be of the same opinion; still others may think very differently, in which case they are heartly welcome to be as free in their strictures upon us as we have been in speaking of the design which is now being carried into execution.

DECEPTIVE ARCHITECTURAL MATERIALS.

II.

We published last month a long letter subscribed "The Writer in the Companion to the Almanac," controverting certain criticisms which have appeared in former numbers of this Journal. It is not worth while to prolong an uninteresting and unprofitable controversy by replying categorically to the letter; at the same time, there are views suggested by it on one subject—that of deceptive materials—which are certainly worth examining. It is a matter of very general interest to architects and those who employ them, that the general question as to the propriety of using deceptive materials, and also the specific questions as to what particular materials are to be considered deceptive, should be clearly and definitively answered.

But a mere unsupported *dictum* will not be a sufficient answer. On subjects like these the reader claims the right of reasoning and examining for himself, and will not be satisfied with simple statements of opinion, however authoritatively pronounced. It will be necessary therefore to observe some sort of method in considering the question, and as we have already assigned in the former paper with the same title as the present one, the abstract reasons for condemning architectural deceptions, we now purpose to examine the specific applications of the general rule.

It may then be first remarked that every rule of art which is of the nature of a restriction must be applied more strictly to works of the highest order than to those of a trivial or unpretending character. So that, in condemning architectural deceptions, the condemnation must be considered to fall far more heavily when it affects important public edifices, churches, collegiate buildings, &c., than when it refers to ordinary domestic architecture. There would, for instance, be no dispute as to the impropriety of making the great doors of a cathedral of some common wood painted in imitation of oak, but it would be mere affectation to object to the use of "grained" deal in an ordinary dwelling room. Neither, we presume, would there be found at the present day many defenders for an architect who constructed an elaborate roof like that of Henry the Seventh's Chapel, of some cement or stucco resembling stone; but it would be absurd to conclude that there was any impropriety in using plaster ceilings in private houses. Neither, again, would it be possible to deny that a chimney piece of wood painted and varnished to resemble marble would appear contemptible in a noble banquetting hall; but it is quite possible to conceive instances where wood painted like marble might be introduced without any grievous offence to good taste.

The more immediate occasion of the present paper arises from the remarks which have been made in defence of the use of *varnished deal*, and as this material has of late been very frequently used in buildings of the highest pretensions, it becomes a matter of great interest to the architect to ascertain under what circumstances its use is justifiable. It is clear that no reason exists for making it an exception to the remarks just made respecting the cases where imitative materials may be allowed, and those remarks are of the more importance with respect to varnished deal, because there are methods of using this substance by which it altogether avoids the risk of being ranked among deceptive materials. In many of the old mansions and seats of the nobility the wood-work is of the Norway pine timber, varnished; and this wood from its superior hardness and closeness of texture compared with common deal, admits of considerable delicacy and minuteness in carving. The grain of the wood also is free from that coarseness which renders deal generally inapplicable for ornamental purposes. The colour of the Norway pine wood when varnished somewhat resembles that of pear wood, and produces a very agreeable effect; the varnish also improves the appearance of the wood by developing its texture and "bringing up" the grain, which often exhibits considerable delicacy.

This point however is particularly to be noticed—that where the Norway pine wood has been used with good effect, there has *never been any attempt to produce deception by artificially disguising the natural colour of the wood.* This remark is most important, because, otherwise, all attempts to *improve* the natural appearance of architectural materials might be considered synonymous with architectural deception. It is very necessary for the consistency of our argument, that this distinction should be clearly made; for otherwise it might lead to most absurd inferences. An unthinking person might, for instance, condemn the polishing of marble on the mere ground that marble when polished presents an appearance altogether different to that which it has in its natural state. But the essential distinction between the improvement of natural materials and architectural deceptions is—that by the latter, a poor and cheap material is made to look like some other well known material, which is more rare and costly. Marble, by being polished, cannot be said to be made to resemble anything more costly than itself; neither can varnished Norway pine *when unstained* be supposed to be a spurious and deceptive substitute for a more expensive wood.

If, however, some cheap common wood, such as the ordinary pine be stained of a dark colour, altogether different from its natural hue, and if moreover, as in the case of the timber roofs at Lincoln's Inn, the stained wood is placed at such a height that the eye cannot detect the poverty of the material by its shapeless knots and coarse grain, it seems impossible for any one but a mere disputer about words to deny that in such a case varnished deal must fairly be reckoned in the list of deceptive materials.

It does not appear any answer to our objection to say that in this case the wood is not *painted.* Of what consequence can it be whether the deception be produced by painting the wood or by staining it? The object of the discussion is to ascertain the *fact* of the existence of deception—not the *mode* of producing the deception. So long as it remains undisputed that a common material is made to look like another, better and more expensive than itself, it really seems wholly immaterial to dispute about the specific means by which the deceptive resemblance is effected. The notice of ceiling at Lincoln's Inn, copied into our pages from the *Athenæum*, stated that the wood was first *stained* and then varnished, and that the colour of the wood was entirely changed; these facts are perfectly sufficient for our argument.

It may appear perhaps that we are prolix and unnecessarily minute on a point of comparatively little importance. This however is not the case. The particular kind of deception which we now notice seems growing into fashion, and believing, as we do, that a great—if not *the very greatest*—barrier to the improvement of modern architecture, is the tendency which has unhappily crept in of using all kinds of tricks and artifices and make-beliefs, we do not think that we can be mispending the time of our reader by endeavouring to set forth clear and explicit notions on the subject. By accurately explaining the nature of one architectural deception, we, by implication, determine the nature of all; and it may be added that it is the want of clear notions on this subject, and not the subject itself, which has occasioned those exaggerated inferences by which attempts have been made to throw ridicule on the important rule of architectural criticism now under consideration.

It is not very easy to see from what cause have arisen the loud remonstrances which have been urged against us in justification of architectural deceptions. Were our condemnation of them an altogether new and unheard-of rule, it might be anticipated that objections would be raised against the doctrine, not on account of any inherent defects in it, but simply for its novelty. But we do not claim the merit of novelty. The doctrine asserted by us has been assented to by almost every thinking writer on architectural subjects; it was rigidly observed by all the ancient architects, both Classic and Christian; and we may observe that in works published at the present day, which contain architectural criticisms, the same principle is universally recognized. We quoted not long ago some remarks from the pages of *The Builder*, respecting the church built of terra-cotta, near Manchester, the tendency of the extract being to show that such a building ought to be condemned, not because of accidental failures in the workmanship, but *per se* as an attempt of the worst kind at architectural deception. To this testimony we might add that of the *Athenæum*, and it would be impossible to read a single number, scarcely a single page of the *Ecclesiologist*, without meeting with numerous censures of the employment of imitative materials.

We repeat boldly that there is scarcely a more fatal obstacle to the advancement of architecture than the system now too prevalent of building showily, instead of well. There is no doubt that those builders who have been trained in the "Cheap Gothic" school will feel much offended to find their mouldings and mullions of patent cement, their walls of stucco panelled to resemble masonry, and their showy-looking ceilings of stained deal condemned for ostentatious vulgarity, but their disappointment does not awaken our pity. From the days of Esop, the jackdaw has been condemned for excessively bad taste in arraying himself in the plumage of the peacock.

It is far better taste to use homely materials honestly and without concealment, than to trick them out with a vulgar unreal magnificence. There is an honest and substantial appearance in good dark brickwork, which is far preferable to the splendour of the best mock-masonry ever constructed. Of the former material some of the noblest and most stately edifices have been built—fine old mansions, ancient gateways, halls and towers; the latter is the type of suburban cockney architecture, it gladdens the eyes of retired tradesmen, and assorts well with those notions of the beautiful which are learned at the counter or in the counting-house. It is perfectly congenial to the taste of the ruralising stock-broker, who prefers that his *rus in urbe* with its patch of garden and smart summer-house should look *spruce* and *trim*, just like the new proprietary chapel-of-ease over the way; who sees no beauty in the old village church with its great sullen tower and dingy frowning buttresses, and pronounces the neighbouring baronial hall (which is coeval) a dull, dark, solemn place, which he would not live in for the world, for fear of growing melancholy and—romantic.

Now though we have no expectation or desire of converting such a critic, the readers to whom we now address ourselves claim that respect by education and profession, that it cannot be a matter of indifference whether they consent to, or dissent from, the views here laid down. We can have no fear that men, who are necessarily compelled to examine for themselves the principles of pure taste, will condemn the honest *real* architecture of the Grecian temples, and our own glorious cathedrals; the only ground of apprehension is that our rules may not be expressed with sufficient clearness to prevent exaggerated and inconsistent inferences. The true criterion as to the deceptive use of materials is—not that the natural appearance of the materials is *improved*—but that an attempt is made to cheat the eye, to impose the belief that what is in reality homely and common is some well known substance of a more costly description. The criterion is altogether independent of the particular method by which the deception is produced, and it is also irrespective of the *degree of successfulness* of the deception. It is no palliation, but rather an aggravation of the evil, when the imitation is close and minute, because in this case the amount of deception is only increased. If a nobleman were to appear at a great public solemnity with false jewels in his insignia, he would certainly be making a display in the worst possible taste, and the vulgarity of his ostentation would not be diminished, if his paste diamonds were so well made that they passed for real.

It is well worthy of remark that the art of imitation has always been most successfully practised in countries and at epochs distinguished by the debasement of the fine arts. A painter who could paint a joint of meat, or a knife with all the minuteness of reality, might certainly claim the credit of being a good mechanical imitator, but could scarcely take his rank among the disciples of "high art." Imitation is the faculty of the Ape, and is most observable among nations least elevated by moral and intellectual energy. Wonderful stories are told of the minuteness with which the Chinese and Japanese imitate natural objects, but none of the lofty beauty of their sculpture, painting, and architecture. The mimetic faculty is seldom predominant in men of original genius, and is never displayed in their greatest works; the substitution of the fictitious for the real, the minute for the beautiful, has uniformly been found to presage the neglect and speedy degradation of the Fine Arts.

ST. MICHAEL'S CHURCH, PIMLICO.

Notwithstanding the rapid advancement of church-architecture during the last few years, it must be confessed to be still in a state of transition from the barbarism of the last age, and to have as yet but imperfectly regained its original purity. A characteristic defect of modern Pointed architecture appears to us to be the want of that boldness and massiveness which distinguished the architecture of the fourteenth century. There is in modern art a general tendency to what may be called, for the want of a better term, *prettyism*. This affectation of smoothness and delicate ornament is especially observable in sculpture and architecture, and in neither of those arts have we the energy and boldness of the old artists. We seem altogether afraid of exercising that kind of courage which produced the strong simple lines, the bold salient angles, the sudden alternations of lights and shadows which distinguish Westminster Abbey or King's College Chapel. And it is the more to be regretted that these simple means of rendering architecture effective should be altogether missed in modern buildings, because they seem to be the very means which should be most valuable at a time when architects are constantly complaining of the parsimony by which their efforts are restricted. Speaking economically, it must be clear that bold simple ornaments must be cheaper than those of more delicate workmanship, and the architect can complain of no one but himself if for want of the former his works appear ineffective.

The new church of St. Michael's, Chester Square, built from the designs of Mr. Cundy, possesses in a great measure that necessary play of light and shadow without which the first and distant view of a church can never be satisfactory. The plan of the building is cruciform, there is a bold tower surmounted by a lofty spire, the roofs are of high pitch, and the combination of the various parts produces a very picturesque specimen of the style adopted—the Decorated. The entrance is not at the west, but beneath the tower which stands on the north side near the north-west angle, and is strengthened by buttresses divided into three stages, and panelled. The buttresses are surmounted by pinnacles with crockets and finials; between these rises the spire which is surmounted by a vane at the height of 160 feet from the ground. The roofs of the church are slated and have floriated crosses at the gables. The whole of the exterior is faced with Kentish ragstone, with Bath-stone dressings oiled to resist the effect of moisture.

The entrance to the church is beneath the tower, of which the lower part is entirely open, and forms an arched portico. Similar examples exist at West Walton, Norfolk; at Dedham, Essex, and in one of the churches at Cambridge. Within the church there is accommodation for 1200 persons, 750 in pews and 450 in free seats. The roof is of open wood-work, and is supported by piers between the nave and aisles. The font which is at the west end, has a cover of carved wood, and the pulpit and reading desk are low, and stand on either side of the "communion recess," which is paved with encaustic tiles. The commandments are written in panels beneath rich canopies, and on the south side are *sedilia*. If these are to be *used* there can be no objection to them in an architectural point of view, if how ever they be useless and are merely for show, the architect would have certainly done well to have omitted them.

Where there is much to praise it is very painful to have to find fault; truth and consistency however compel us to state that there are many things in the interior arrangement of the church which cannot be praised. There are galleries intersecting the piers and blocking up the side windows; the shafts attached to the piers have poor bases which are hoisted on a species of stilts to the level of the pew-seats. But above all there is an appearance of *unreality*, objectionable in all kinds of architecture, but perfectly indefensible in that kind which ought to be the very highest and most truthful—church architecture. The walls of the church and of the staircases are coated with plaster on which black lines are drawn to imitate, or rather, mimic the courses of real masonry. Some of the window mouldings are "run" in cement, and are the more deceptive because the mullions and corbels are of stone. The same remark applies to the shafts attached to the piers, which are partly of stone and partly imitations; the piers themselves are all of plaster decorated with the black lines aforesaid. The pews are of stained deal. Of the value of this material we have pronounced a sufficiently explicit opinion in another part of our present number. It may be added that here the coarse shapeless knots of the wood and the harsh lines of the grain have a very disagreeable effect. The glazed and shining appearance of varnish is, to our taste at least, very objectionable. This however is merely an individual opinion,—but it is a matter of certainty that the effect is very unchurchlike.

We regret also to find the appearance of sham windows—indentations or shallow recesses in the plaster of the walls, with imitation hood-mouldings in cement. In the exterior of the church there is also apparently an untruthfulness about the western side which is treated as if it were the *back* of the church, (a church ought to have no back or inferior side,) for on this side we find nothing but plain blank walls of masonry without ornament, and with a surface entirely unbroken, except by one or two very small windows in the upper part. This defect is certainly not necessitated by the site of the church, which is quite isolated. The western side is not quite so conspicuous as the other sides, still it is far from being actually concealed. There are indeed houses on the north side, but at such a distance as to leave plenty of room for viewing the building in that direction.

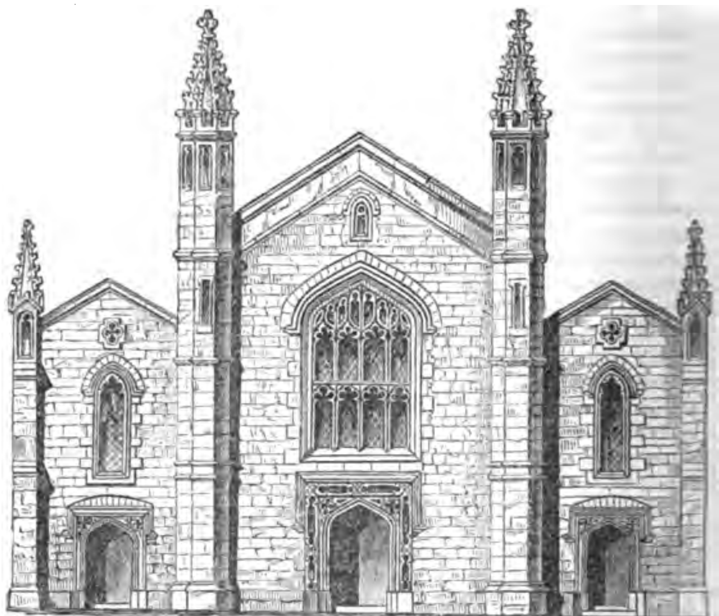
It is very tedious to have to repeat the same obvious truths over and over again. But till the lesson is perfectly learned and practically exemplified we must not cease to set forth the truthfulness and honest sincerity which the old builders scrupulously observed in their works. To express a species of excessive vulgarity by a vulgar phrase, there is in modern church-building a tendency to *show-off*, which is utterly repugnant to the principles of good taste. And not only is this ostentation and affectation of fictitious magnificence contrary to reason, but it is against precedent also. The old architects uniformly used real materials and were never guilty of leaving one side of a church poor and unembellished that they might lavish richer ornaments on the conspicuous parts. Until our own times the art of make-belief decoration has been monopolised by milliners and scene-painters.

We must not be understood to express these sentiments in an unfriendly spirit. The architect of St. Michael's Church cannot be censured for the existence of a widely-spread error which is doing the greatest possible injury to architecture, and which we boldly affirm *must* be corrected before the constructive arts can regain their original excellence. At the same time we must express regret that in the present case the architect should have fallen in with a bad custom, and we sincerely hope to see many excellent works of his, as bold and effective in design as St. Michael's church, but free from its faults in detail.

There is one good arrangement with respect to the comfort of the future congregation of the new church which must not be passed over. The church is warmed by hot-air pipes, which are contained in channels in the floors covered by grating. There is nothing like concealment here; the pipes honestly reveal their purpose—they are not *concealed*, but they are put where they do not obtrude on the sight, and are simply rendered inconspicuous. We have no doubt that the titled congregation who will frequent St. Michael's, will prefer this arrangement to the delightful inventions of the Cambridge Camden Society.

The first stone of the church was laid on the 20th of May 1844, by the present Marquis of Westminster, who subscribed 5000*l.* towards the building, and gave the fee simple of the site. The remainder of the cost must be raised by subscription before the church can be consecrated. There is at present a deficiency of 5,200*l.*, which includes the cost of an organ, bell and clock, and of inclosing the church-yard.

CHRIST CHURCH, PLYMOUTH.



The accompanying illustration represents the elevation of a Chapel-of-ease recently erected in the parish of St. Andrew, Plymouth, from the designs of Mr. Wightwick, to whose courtesy we are indebted for the sketch from which our view is copied. Mr. Wightwick has also favoured us with some brief but very pertinent observations on the strictures which appeared in the January and February numbers of this Journal, respecting the manner in which light was obtained in the new building. He says,

"I do not exactly see that a church united with other buildings is necessarily so beyond all successful treatment as you suppose. Is it *quite* fair to call the only front that shows "a show front?" Is there any thing "unchurchlike" in the "arrangement" by which I obtain light? viz., by a clerestory? 3rdly. The adjacent buildings harmonise with the church in style; the one being a residence of a simple Tudor character; and the other a School-building literally belonging to the church. Furthermore the building is but a Chapel-of-Ease."

With respect to the use of the word "unchurchlike," we would observe that it was meant to refer, not to the admission of light by clerestory windows, but to the non-admission of it by aisle windows. It must be obvious that when a church is lighted by clerestory windows alone, either the amount of light obtained must be insufficient, or else these windows must be so enlarged as to become very prominent features of the architecture, or at all events, to lose that subordinate relation which they bear in ancient churches.

The omission of aisle windows has also this disadvantage, that the whole of the north and south walls are broken and unbarred; and this again is contrary to precedent, for in ancient examples large surfaces of "dead" wall are uniformly avoided. Another disadvantage arising from the same cause is that the quantity of light obtained in the centre aisle must far exceed that in the north and south aisles. In Christ Church the lateral aisles contain galleries extending from the walls to the piers of the nave;* and it is certainly against usage that a lateral aisle of a church should as in this case be divided into two stories or compartments, each of which constitutes a spacious windowless recess.

Light obtained from upper windows alone produces an effect very different to that to which we are accustomed in Pointed Architecture. The lights and shadows are, so to speak, reversed. This may seem at first sight an unimportant remark, and one rather of an artistic than architectural nature, but if the reader will compare a building lighted by vertical

* We had formerly understood that these galleries did not intersect the piers.

lights in the roof (such as the National Gallery, the Elgin Room of the British Museum, &c.) with a chamber in which there is a series of side windows, he will see that the effects produced are totally different, and as the beauty of Christian Architecture depends most materially on the disposition of light and shadow, this consideration is by no means to be neglected. We never should expect to meet with an ordinary *skylight* in an ancient church; in that case, it is *immediately* obvious that the effect would be contrary to the spirit of Pointed Architecture. It needs, however, but little reflection to be satisfied that there is a similar objection to the exclusive employment of clerestory windows. By the arrangement of windows similar to that in the National Gallery the light is so generally diffused that it nowhere casts strong sharply defined shadows; this arrangement is therefore very advantageous in a Museum of Art, but the effect produced is essentially secular, and very different to that "religious light" which is so beautiful a characteristic of the Mediæval churches.

It is however by no means necessary that a church should be built in a perfectly isolated situation. Our noblest cathedrals have attached to them accessory buildings (Cloisters, Chapter-houses, &c.) of corresponding date and architecture. Much injury has indeed been done by the injudicious temerity of modern "restorers" in their zeal to isolate ancient churches. We may here perhaps refer to M. Didron's vehement denunciation of the Vandalism which has recently destroyed the Chapter-house at Troyes, and which contemplates a similar destruction at Rouen under the pretext of revealing the beauties of the Cathedral itself. But though it be perfectly allowable, and frequently desirable that a church should have dependent buildings attached to it, there seems no warrant whatever for so placing those buildings as to prevent the admission of light to the church by aisle windows.

Of course these remarks must be considered perfectly general in their tendency; it would be absurd to censure the architecture of the new chapel at Plymouth because the architect has not performed physical impossibilities. On the contrary, there is every reason to suppose that his expedient is the very best which the circumstances of the case admitted. At the same time it is one which can never be defended, except on the ground of absolute necessity, and we certainly should never feel disposed to approve of the omission of aisle windows, unless the question lay between building the church without them—or not building it at all.

AMALGAMATION AND LEASING OF RAILWAYS.

In continuation of the papers on this subject, that appeared in the Journal for October and December 1845, my only apology is the difficulty of getting this description of information after until the period at which it appeared in the public papers, and although these papers may not claim the merit of original thought, yet their computation at the period of the Railway Fever of 1845, the one previous and the other after the dreaded month of November, may in itself be some merit. In the last paper speaking in reference to the new infusion of lines of the session of 1845, and the position of the remnant of the new lines that has not formed any alliance with the old companies, an alliance was indicated as probable, and which has since taken place, as will be found in the after part of this paper.

The remnant of lines not yet allied to, the old companies is reduced to the Kendal and Windermere, Cockermouth and Workington, Newport and Pontypool, Weir Valley, Richmond (Surrey) and Leeds and Thirsk and these may be further reduced as the latter line, and the Great North of England have come to an understanding so as not to compete, and the Weir Valley may be said to have the same interest as the Stockton and Darlington. As regards Scotland, the following are the groups into which the railway interest have naturally divided this country entirely from the East Coast; we have the North British, Edinburgh and Hawick, Edinburgh and Dalkieth, and meeting with the West Coast Interest at Peebles, which may be considered as a fixed point. The Western write to be obtained from Carlisle, is by the Caledonian Line, 137 miles long, which is united with the Clydesdale Junction, Pollock and Govan, Glasgow and Garnkirk, and Caledonian and Dumbartonshire Junction, and West of the meridian of Glasgow, and North of Carlisle, is the group proposed to be called the Great South Western of Scotland, composed of the Glasgow and Greenock; Glasgow, Kilmarnock and Ardrossan, and Glasgow, Paisley, Kilmarnock and Ayr, and Glasgow, Banhead and Neilston Direct, and taking the parallel of Edinburgh and Glasgow, we have the Edinburgh and Glasgow, and Lanarkshire Lines, viz: Ballochney, Slamannan and Monkland and Kirkintillock, also the Glasgow Junction, Scottish Midland, and Scottish Central, and Coupar Angus, and Glammis; and East of Edinburgh, and North of the Firth, we have the Kingdom of Fife group, the Edinburgh Northern, and Edinburgh, Leith and Granton, and from Perth Northward, we have the Dundee and Perth, and Dundee and Newtyle, and its continuation by the Dundee and Arbroath, Arbroath, Forfar and Aberdeen.

The following are the groups of alliances in England. South of London, and to the East, we have the South Eastern to the West, the South Western, and intermediate the group of Lines compressed in the London and Brighton.

The district seems fairly assigned to each, and the three companies are on friendly terms, and disposed to become consolidated; indeed, two years ago, the South Eastern offered 100,000*l.* per annum, for the Brighton, which would have been just equal to the present dividend.

North of London, and to the East, is the group composed of the Eastern Counties, Northern and Eastern, with proposed Extension to York, and the Norfolk, East Anglian, and Eastern Union, and its Extension.

North of London, on the East Coast, is the Midland, from Bristol to Berwick.

North of London, on the West, the Great London and Liverpool extension, to Carlisle.

London to the West, the first group Line is the Great Western, which with the London and Birmingham occupies the whole of Wales, the one South, the other North.

The Second Cross Line is from Liverpool to Hull by the Manchester and Leeds.

The Third Cross Line is from Manchester, by the Sheffield and Manchester, Hull and Barnsley Junction, and Sheffield and Lincolnshire.

The Fourth is from Shields on the East to Maryport on the West Coast, by the North Coast and Carlisle.

The above general view may be confirmed in detail by a reference to the former papers, and the amalgamation there indicated, and since taken place, is the East Anglian.

The Board of Trade having ceased to report on new schemes, I record their period of influence. The total notices together were eleven, the first appeared 31st Dec. 1844, and then in January, 14, 17, 24. Four in Feb. 4, 7, 18, 28. Three in March; and nineteen reports were published, accompanied with twenty-one maps of districts into which they had divided the country, and the name of the different districts and date of reports are as follows.

First, Feb. 13. Kentish and South Eastern.

Second, Feb. 24, Manchester and Leeds, and Newcastle and Berwick.

Third, Feb. 28. District of Berks, Hants, Wilts, Dorset and Somerset, —District, London, Worcester and Wolverhampton—District, Birmingham and Shrewsbury.

Fourth, March 4. Norfolk and Suffolk, Cornwall and Devonshire.

Fifth, March 13. Trent Valley, North and North West of Ireland, approaches to the Metropolis and Scotland.

Sixth, March 20. London and York, West of Dublin, South of Ireland, South Wales.

Seventh, March 31. Colchester and Harwich, Portsmouth, North of Leeds and West Riding.

Eighth, April 16, 1845, Lancashire.

The influence of these reports will be felt in the present session. The Chairman of the Great Western at the Meeting, Feb. 12, 1846, says, "There could be no doubt that under the report of the Board of Trade, the traffic of Exeter and Yeovil was to be provided for by the Great Western." The Chairman of the South Western at the Meeting, January 21, says, the Great Western would not treat for a friendly alliance until the Board of Trade reported in January 1845; the Board of Trade made their report, and was appointed mutual arbitrator and sole referee betwen the two companies, which, however, the G. W. R. now decline, and the Board of Trade declined to interfere, and the Chairman further says, "An opposition was eventually made to that board, which could not be foreseen. Lord Howick commenced it in connexion with the atmospheric, and others followed by which the Board was overthrown." From the above there can be no doubt the quarrel between these two powerful Companies will be much perplexed, by the record of the Board of Trade Report. Nevertheless we have the experience of the last session, that the Committees of Parliament are jealous of this interference, and are prepared to act independently as they sanctioned the following lines contrary to the report of the Board.

Leeds Dewsbury and Manchester, Exeter and Crediton, Lynn and Dereham, Londonderry and Coleraine, Londonderry and Enniskillen, Irish Great Western, (Dublin to Mullingar,) Leeds and Thirsk, Shrewsbury, Oswestry and Chester, Ely and Huntingdon. The abandonment of a portion of the Great North of England and Eastern Counties Line, seems to have had great influence with the Board.

I have been curious to know what lines, for which Acts of Parliament had been obtained, havebeen abandoned, they are as follows: 1811; Berwick and Kelso; 1812, Penrhynn; 1814, Mambilad; 1816, Peak Forest; 1825, West Lothian; 1826, Dulais, Manchester, Oldham, Limerick and Waterford; 1831, Rutherglen and Wellshot, Lanarkshire, Sheffield and Manchester; 1832 Exeter and Crediton; 1836, London Grand Junction, Thames Haven, Launceston and Victoria; Deptford Pier. In looking over the above it will be seen at a glance that many of the projects are carried out by Companies incorporated since.

I will now proceed to give a general summary of the acts of each Session, and those which were refused the sanction of Parliament, although from want of data I cannot separate those refused into the two heads of New and independent Lines, and those promoted by Old Companies, or being amendments of former Acts. The first Act was passed in 1801, and; in 1802, two; 1803, one; 4, one; 8, one; 9, two; 10, one; 11, three; 12, two; 14, one; 15, one; 16, one; 17, one; 18, one; 19, one; 21, one; 23, one; 24, two; 25, five; 26, six; 27, six; 28, eleven; 29, nine; 30, eight; 31, nine; 32, eight; 33, eleven; 34, fourteen; 35, eighteen; 36, thirty-five; 37, forty-two; 38, sixteen; 39, twenty-six; 40, twenty-four; 41, nineteen; 42, twenty-two; 43, twenty-four; 44, forty-eight; 45, one hundred and twenty; and 1846, seven hundred and twenty-one applications. And commencing with the same period, there are distinct titles of new Companies, and old ones with a distinct application exclusive of amended Acts, 1801, one; 2, two; 3, one; 4, one; 8, one; 9, three; 10, one; 11, two; 12, one; 15, one; 17, one; 18, one; 19, one; 21, two; 24, two; 25, seven, 26, seven; 27, one; 28, five; 29, six; 30, five; 31, three; 32, four; 33, five; 34, five; 35, nine; 36, twenty-four; 37, thirteen; 38, two; 39, three; 41, one; 42, four; 44, sixteen; 1845, sixty-two; being upwards of 200 Railways with distinct titles, no Act is dated in 1805, 6, 7, or 1813, 14, or 1815, or 1820, 22, 23, or 1840, and 1843. Commencing with 1801, the number of Railway Bills, that was passed in each session, that I can find account of is the following: in 1826, two; 1826, one; 1830, five; 1832, four; 1833, five; 1834, four; 1836, twenty-four; 1837, forty; 1839, nine; 1840, seven; 1841, six; 1842, five; 1843, ten; 1844, twenty-three; 1845, one hundred and five.

I will now proceed to give an account of the alliances formed since the preceeding paper, viz:

Dundee and Newtyle, leased in perpetuity to the Dundee and Perth, at an annual rent of 1,400*l*, or 1¼ per cent.

Edinburgh, Leith and Granton, amalgamated at par with the Edinburgh and Northern, on a capital of 310,000*l*, the preference shares are guaranteed 4 per cent, by the united companies, and 1 per cent by the original stock, of the Edinburgh, Leith and Granton, Lancaster and Carlisle, with the Lancaster and Preston Junction.

Arbroath and Forfar, leased to the Aberdeen, from the 1st Feb. 1848, at a fixed rent of 5½ per cent, and half the surplus profit, after deducting 3½ per cent for working, the lessees have the option after 5 years of working as a basis, to fix the amount of surplus profit to be paid the Arbroath and Forfar Company.

Scottish Midland, agreed to be worked by the United Scottish Central; and Edinburgh and Glasgow Companies, at 37½ per cent on the gross receipts, guaranteeing a dividend of 4 per cent for 5 years, and to amalgamate at the end of that period, on the basis of the receipts of each line for the last two years preceeding. The Scottish Midland purchased the Coupar Angus Line for 15,000*l*., and the Glammis for 21,000*l*.

Huddersfield and Manchester repudiate the lease to the Sheffield and Manchester, and set forth the Leeds and Thirsk, and Leeds and Dewsbury, as their natural allies, and that hereafter better terms may be obtained either from the Manchester and Leeds or the Sheffield and Manchester.

Leeds and Bradford, with Manchester and Leeds, two of the former converted into one of the latter Company's. 675,000*l*., of new Manchester and Leeds fifths to be distributed among the Bradford proprietors. The Midland Branch to belong to Midland, York, and North Midland, and Manchester and Leeds Companies, and the Midland to run their trains to Bradford; equal calls and dividends and contributions to increase of capital and proportionate dividend in the interim.

East Anglian, name taken by the Lynn and Ely, Lynn and Dereham, Ely and Huntingdon, amalgamated Companies, which took place as from 1st January, 1846, the Extension of Lynn and Ely apportioned among the proprietors of each company, one new share for one old. The amount paid is only 3½ per cent until completed, whilst most Companies pay 4 per cent.

Chester and Birkenhead, leased for 7 years to the Chester and Holyhead on the capital Stock, 5 per cent for the first year, 6 for the second; 7 for the third; and 8 for the last four years.

Edinburgh and Glasgow, with Ballochney, Slamannan, Monkland and Kirkintillock Lines, the arrangemen tis taking the Edinburgh and Glasgow at 100, the proportion allowed is respectively 37½ for the first, and 21 for the two remaining lines.

Great North of England, Clarence and Hartlepool Junction, amalgamated at par with the Hartlepool Dock and Railway. Capital 80,000*l*., to pay 3 per cent from July 1846, to 1848, and 5 per cent to 1849.

Hartlepool Dock and Railway, sold to the Newcastle and Darlington Junction, for 220*l*. per 100*l*. share, to complete in 5 years, 10 per cent in the interim, the Share Capital 813,220*l*., and 52,250*l*. of the debt to be converted into ¼ shares, and included in the arrangement. The old shares and quarters to be entitled to the issue of one sixth, possession to be given on the 30th June, 1846.

London and Birmingham Railway, and Birmingham Navigation Company.

The Southampton and Dorchester, with the London and South Western.

The mere projects have not been less active in reconciling conflicting interests, and the following alliances or amalgamations have taken place.

North Staffordshire, with Derby and Crewe.

Reading and Reigate, with Reading, Guildford and Reigate.

Welch Midland, and Newport, Abergavenny and Hereford.

Waveney Valley, and Ipswich and Norwich.

South Eastern, and Dover, Deal, and Cinque Ports.

London and York, and Huntingdon, St. Ives, Wisbeach, and Sutton Union.

Chepstow, Forest of Dean, and Gloucester, with Welch Midland Extension.

Birmingham and Leicester, and Direct Birmingham and Leicester.

Leeds and Carlisle, and Yorkshire and Glasgow Union.

London and Birmingham, with Birmingham, Wolverhampton and Stour Valley; Shrewsbury, and Birmingham; Dudley, Madeley, Broseley and Iron Bridge United Company.

Worcester, Warwick and Rugby, with Rugby, Warwick and Worcester, and Warwick and Worcester.

Manchester and Rugby Direct, and Churnet and Blythe.

Lincoln, Wainfleet Haven, and Boston, and Great Grimsby, Lincoln and Louth.

Goole, Doncaster, Sheffield and Manchester Junction, and South Yorkshire Coal Company.

Sheffield and Lincolnshire, and Manchester and Lincoln Union, and Gainsbro' Canal.

Trent Valley, Midland, and *Grand Junction*, and South Staffordshire.

Worcester, Hereford, Ross and Gloucester, Great Western, with the Worcester and South Wales Junction.

Aberdeen, Banff and Elgin, and Great North of Scotland.

Scottish South Midland, and Stirling and Dunfermline.

Edinburgh and Leith Atmospheric, and Direct Edinburgh and Leith Atmospheric.

Tyne Valley, and East Lothian Canal.

Midland Great Western of Ireland, and Extension to Galway and Sligo, and the Liffey Branch, Longford Deviation.

Scottish Grand Junction, now only from Oban to Lochlomond.

Forth and Clyde, on friendly terms with Scottish Central, and Caledonian and Dumbartonshire.

The following Lines are Abandoned for the Session.

Chepstow, Forest of Dean, and Gloucester.
Liverpool, Preston, and North Union.
Wolverhampton and Birkenhead.
Birmingham, West Bromwich, and Walsall
Hull and Great North of England.
Fleetwood and Clitheroe.
Birmingham and Dudley
Wolverhampton, Chester and Birkenhead.
Birmingham and Worcester.
Huddersfield, East and West Coast,
Great Welch Central.
Trent Valley Continuation.
Whitby, Pickering, Thirsk, and Great North of England.
North and East Riding.
Renfrew and Ayr Counties.
Sanquhar and Muirkirk.
Scottish North Western.
Arbroath and Stonehaven.
Lancashire and Eastern Counties.
North Cheshire.
West End and Southern Counties.
Regent's Canal Railway.
Isle of Wight.
Direct London and Exeter.
Great North and South Wales, and Worcester.

CAUSE OF THE CATASTROPHE AT BARENTIN.

Our professional correspondents write to us expressing their inability to make out the truth regarding the recent catastrophe of the Barentin viaduct, and their desire to obtain such authentic intelligence regarding the facts of the case as may enable us to guard, if possible, against the recurrence of similar casualties, so disastrous to railway enterprise. Similar accidents have happened in this country, generally from injudiciously tipping the stuff out of wagons on the arches while yet very green, and unequally loading them so as to push in the haunch, and raising up the crown so as to destroy the equilibrium of the arch. In other cases, the foundation has given way; but this Barentin case appears still to be a mystery.

From the French papers we have endeavoured, but in vain, to gather consistent intelligence. The statement seems directly opposite, and so mixed with prejudice and manifest ill-feeling, that it is not possible to ground any tolerably consistent opinion on their statements. Even the French railway journal contradicts itself flatly, so as to display either the greatest ignorance or the greatest prejudice, on a subject on which everybody would naturally have expected it to be intelligent and just. We have it one day assuring us that the structure was built in conformity with the plans of the engineer, that the railway company must therefore incur all the loss, and so leading the shareholders in this country to believe that their plans were faulty, and that a design, of course ill-proportioned and injudiciously planned, was the *origo mali*. Then, next week, we find in the same journal a letter from the contractors themselves, giving the lie to the journal, and stating that the work was altered from the plans to suit their wishes, that they held themselves and not the company responsible for the loss, and that they were immediately to recommence their work. This is a little creditable to the English contractors—creditable to Mackenzie & Brassey, of whom we expected no less; it is in every way calculated to enhance their character, which is respected both abroad and at home, and it is also a step which must tend to give the public confidence in whatever they may in future undertake. It also justifies those directors of the company who have reposed in them implicit confidence for the execution of works of enormous extent, and gives confidence also to English shareholders. But what are we, what are the shareholders in England, to say to a French journal, which professes to watch over their interests in France, and yet spreads false alarms among them and the public, so periling the value of their property, by increasing the fears it ought to have assuaged by a judicious and well-timed statement of the truth, and, when obliged to publish an official contradiction from another source, does not even frankly apologize for its former delinquency, nor advert to the injustice of which it had been guilty? Surely, it is manifest the interests of shareholders are not safe in such keeping.

We have, therefore, endeavoured to obtain from our correspondent, from the spot, a true account of the accident; and we now give our readers, with the assistance of his sketches, a fair and tolerably precise account of the matter. But, first we give the contradiction referred to.

The following letter was addressed to the editor of the *Journal des Chemins de Fer*:—"Sir,—In reply to the article in your number of Saturday last, we have the honour to inform you that we take upon ourselves the whole responsibility of the accident, and will begin to rebuild the viaduct without delay. We are not in a condition to say with certainty how the accident originated, but are disposed to attribute it to the substitution (with Mr. Locke's approbation) of stone-work in the bases of the piers for the brick-work prepared in the original plan. This alteration was made at our request, with a view to accelerate the progress of the work, and fulfil the engagement we had contracted with the company.—We have the honour to be, &c. MACKENZIE & BRASSEY."

The arches are semicircular, and designed of ample dimensions and strength—some engineers, whom we know, would have been satisfied with considerably less strength. The whole work was brick, excepting the bases of the piers, which were of stone; and the fact is unquestionable, that on the day before the accident not the slightest flaw had been discovered in any part of the brick-work, but that vertical cracks near the corners had been observed in the stone-work. Now, be it observed, this stone-work was ashlar facing hearted with rubble. Let our engineering reader look at the plan, and then let him think over the probable effect of this—taking into account, as we formerly stated, a little haste and a great deal of wet weather.

We must here notice a sort of professional controversy which exists in France between the English engineers and the French. We English like brick-work—we understand it, and we make it good, so good that from one end to the other of the railway, not a single flaw could be detected by the inspector-general in any part of the brick-work of the line. The French engineers do not like brick-work. They are, perhaps, better acquainted with stone, and certainly like it better. Be this as it may, the consequence, as regards this work, has been as follows:—This bridge was originally designed by the engineer and contracted for as *all in brick*. The contractors partly to expedite the work and partly to please the French engineers, asked leave to make the bases of the piers up to a certain point in stone-work: they obtained the permission of the engineers to do so; and thus, in a desire to expedite the work and to please the French engineers, they have brought on themselves a loss, in which we must all sympathize with them, and which we can attribute to nothing but the best intentions. This casualty, while it entails pecuniary loss, will raise the character of the contractors for honesty and responsibility, both here and abroad.

Well, to return to the accident. This stone base was 19 feet greater diameter than the brick pier resting on it. The chief pressure of the weight of pier and bridge was thus brought to bear on the rubble hearting. The tendency of this to crush the hearting and burst the facing is manifest. The vertical cracks visible that morning in the stone casing were evident symptoms of it; and as the upper work was perfectly sound, and had been some time completed, and as the pile foundations are still perfectly sound as far as can be discerned, the cause is manifest.

The lessons it teaches are also obvious: we are all wise *after* the fact—we can all *now* see that it was weak to yield to an idle prejudice and not use brick throughout as intended—we can all see that it would have been better to wait until the bricks were got, than to build work to tumble down! But who would have ventured to say beforehand, to this point may you go, both in haste and in materials, and no further? No! Contractors and engineers must often make sacrifices of mere opinion to accomplish what they conceive their duty to the companies they serve; and if in doing so, they commit errors, they are but men gaining experience, and they have to pay for it. But in this country, at least, when they bravely set their face to do their work honestly and well—and when taken as a *whole*, the work is honestly and creditably done, as everything is that English engineers and English contractors have done in French railroads—they will meet with that sympathy and support from their countrymen which they have a right to expect, and they will be entitled to that respect and esteem abroad, which their achievements must command from all right-minded and judicious men.—*Railway Chronicle.*

TRACT ON VOLCANOES, SPRINGS OF HOT WATER, AND EARTHQUAKES.

During the period of my altering the hot-water baths, at Buxton, in Derbyshire, I was naturally led to reflect upon the causes of the various hot springs of water, and the regularity of the supply, and temperature at every season of the year. Thirty-five years have since elapsed, and the interval has afforded me many opportunities of judging whether the notions which I then entertained were correctly founded, and whether they deserved to be promulgated.

Reading lately in a Colonial Journal an article on Volcanoes, which contains the following remarks, I have been led to set set down the conceptions alluded to, and in reference to the writer's observations, viz:—

"When these fires were kindled, by what sort of fuel they are still maintained, at what depths below the surface of the earth they are placed, whether they have a mutual connexion, and how long they may continue to burn, are questions which do not admit an easy decision. The greater number of volcanoes rise in a cone, their mouth or crater, has generally the shape of a cap or an inverted tunnel; but in some instances the lava breaks out at the sides. When the fires find no issue they produce earthquakes. When Vesuvius throws off its inflammable contents by moderate and regular eruptions, the inhabitants of Naples have but little to dread on, the occurrence of an earthquake: after a long repose the volcano breaks out with additional force; the extent of its influence is astonishing; that of Tomboras in one of the Islands of the Indian Archipelago, was felt through a circular space of 2000 miles in diameter."

I submit with great diffidence whether it may not be possible to show that the origin of almost all the internal heat of the earth arises simply from the attraction of the particles composing it, in fact constituting an universal pressure, greater in the exact ratio that these particles collectively have to one another. Let me instance, what we all know, that independently of the qualities of the component soil, in every perforation into the body of the earth the temperature increases regularly with the depth of perforation, and that the water when reached has always a warmth proportionate to its depth under the incumbent soil, thus natural rivers have at their original springs (if constant) a warmth which in the coldest weather prevents their freezing, and it has been ascertained that the well at Paris, the deepest we believe ever executed, gave a high temperature much above the heat of any other artificial spring.

Let me endeavour to explain my views by observing, that admitting as a theory, that the attraction or condensation of the materials of the earth, and simply sea sands, I conceive that at some enormously great pressure I believe they would be vitrified, I placed under Bramah's Hydrostatic engine, a short square column of Portland stone, viz. 2ft. 7in. high, and 1ft. by 1·2 at bottom and top; this piece of stone burst asunder with the pressure 173¼ tons, the fragments being then quite hot, and the fracture was attended with a report as loud as that of a pistol. Now admitting that the pressure of each portion of the surface of the earth 1·2 by 1ft., superficies, produced a heat such as described under the pressure of a column equal to the weight of 1737 tons, an increased height may reasonably be supposed to generate heat in the same progression until at length such heat would be produced, that expansion would follow, and at length a volcano takes place in some place of the west of the globe, probably where as at sea there is the least incumbent weight, or in some district of country where the nature of their constituent materials opposed the least resistance to expansion.

With respect to the heat of water, the reflection on the most considerable geissers gives the same inference, for let us admit that water shall percolate the fissures of the earth to a great depth, and that its incumbent weight produces heat to such an extent that it boils over, and that after the heat escapes a temporary subsidence takes place, thus the exceptions of the geisser does not re-occur until heat has been again regenerated by the same pressure which before produced it.

Possibly it may be opposed, that the regularity of Buxton, Baths, and other overflowing hot springs does not lead to this conclusion; I am inclined to think that where there are natural cavities in mountains which are recipients of water, and when the incumbent pressure is not excessive, and where there are orifices which discharge the superabundant water, it is not irrational to suppose that the vents just referred to perform the office of geissers, and as there is no obstruction to them by the narrowness of their orifices, or vast height of columns or water, violent discharges do not take place.

A further observation on volcanoes, and earthquakes may perhaps deserve attention, namely, that in the districts where they have more particularly been attended to, the component soils are in themselves of a nature liable to the action of fire. Sulphur abounds near Etna.

It may be said, that admitting this doctrine of the generation of heat and the self-discharge thereof by its escape by volcanoes, and the invasion of hot water, and hot vapours, yet there must be some portions of the earth where these efforts of nature do not appear to take place. To this I reply that we are so ignorant of the lowermost structure of the earth, as to the inclination of their various beds, that it is possible Hecla the great vent of the North, may serve as the chimney of a great region, and that the other volcanoes mentioned in the remainder of the article first referred to, may discharge the superabundant heat of other portions of the Globe, for it is notorious that earthquakes are felt 20 or 30 degrees of longitude distant from the places where such eruptions have taken place.

It is therefore, I trust, no presumption to entertain those ideas that so long as gravitation exists, there will be a generation of heat, and consequently that this discharge of heat, is an important dispensation in maintaining this Globe, and that although sometimes dreadful visitations are witnessed, yet they are not without their benefits to the great bulk of mankind.

John White.

Paddle Box Boats Abandoned.—The *Retribution* steam-frigate, Captain Lushington, having returned her paddle-box boats to the Portsmouth dockyard on account of their great weight (12 tons,) will not have any more paddle-box boats fitted, and the paddle-box is accordingly already built up in the usual way, it being apparent that the vessel can carry conveniently as many boats as are necessary on board and upon her quarters, without encumbering herself with such heavy appurtenances. The removal of the paddle-box boats has given this fine vessel a much more sightly and light appearance, and no doubt will ease her in sea-going. She is being fitted with a connecting beam to strengthen her paddle-boxes.

REVIEWS.

An Essay on an Improved Method of Construction for Viaducts, Bridges, and Tunnels, being an Application of the Principle of Universal Gravitation, as illustrated in the Solar System. By Messrs. Blair and Phillips, Architects and Civil Engineers. London: Weale, 1845. 8vo. pp. 10.

We are constantly called upon to criticise opinions which evince incorrect conceptions of mechanics, but we seldom or never have criticised any dissertation in which the laws of nature are so gloriously confounded together as in the pamphlet before us. To most (we hope, all) of our readers its title will sufficiently explain its merits: the laws of motion and those of equilibrium are throughout taken as identical; the equilibrium of arches, &c. is referred to the "principle of gravitation as illustrated in the *Solar System!*" *Risum teneatis amici?*

We will not attempt anything like serious argument respecting the views propounded in the pamphlet. It is necessary to a satisfactory discussion that the disputants should have *some* similar views: we should imagine, however, that Messrs. Blair and Phillips have not one idea in common with us respecting the theory of the arch. Dissimilarity of opinion may reach a point beyond which argument is fruitless. It is possible to diverge so far from the highway of received opinions as to render a return to it absolutely hopeless. Our authors seem in this predicament. However, that the reader may judge for himself as to the possibility of their hereafter returning to the paths of orthodoxy, we give one or two short extracts.

"If an arch be turned over any opening, and a wall be built upon it, the arch supports very little besides itself. There is no weight for it to support, because the position which a regular wall takes is that of a continued series of corbels, which corbels meet in the centre, and form a direct line from the centre to each pier. This reminds us of a general law of gravitation by which *all bodies, when unimpeded, fall directly to the earth's centre, and, if impeded, take a direct line tending in some degree towards that centre.*

With this law of nature before our eyes, let us examine—1st, the semicircular arch. This form of arch is used very much, and is by many considered of great strength. Now we wish to show that of itself this arch is very weak. It is weak, because, when a weight is placed on any one part of it, there is great danger of it becoming deformed."

The remarks are illustrated by absurd diagrams in which arches are represented as distorted by a superincumbent pressure into all kinds of impossible shapes. The authors seem to think that when an arch fails it is by the slipping of the voussoirs on each other; whereas in practice it is universally found that the friction of the voussoirs is so great that they cannot slide, and that the arch can only fall by the opening of the joints. The point endeavoured to be elucidated by these diagrams is that *all* curved arches must be distorted by pressure upon them, and that a perfectly flat arch is alone free from this danger. The *reasoning* is as follows:—

"Why is this? The reason is evident. The line of the arch is curved, and as curved (and in proportion to its curve) liable to bend.

"*We come then to our great point, namely, that weight falls in direct lines, and not in curves, as is supposed;* and the nearer our supports approach to a straight line, the more strength we obtain. If this is true and it cannot be denied, the elliptical arch is of all arches the weakest."

It really is no more than charitable to inform the writers that the strength of an arch depends not only on its curvature but also on that which they have altogether neglected to consider—the depth of its voussoirs.

We are informed by our authors that they take no credit to themselves for the plan of building arches flat, but they pronounce the whole body of civil engineers blockheads for not having previously thought of it.

"It may, however, and, we doubt not, will be said, that what we advance is plain and easy, and that we need not claim to ourselves any credit for introducing it. We acknowledge that it is both plain and easy; indeed we stated this at the commencement of our description. But who is he that has applied this plain and easy method? If we cannot claim any credit, surely they that have overlooked what we have now taken up *may be set down as ignoramuses, and not deserving the name and title of civil engineers.* For why should the best method of construction be set aside, and an inferior one adopted? Why should thousands and tens of thousands of pounds be thrown away in that which is worse than useless—injurious? And why should we praise *men who, directly in face of the laws of the universe,* would erect a fabric whose stability they doubted, or which would not stand the test of time and the researches of science?"

After this the least that the Institution of Civil Engineers and the Institute of British Architects can do, is to ordain a fast and go into mourning.

A Complete Treatise on the Oblique Arch. By Peter Nicholson. Third Edition. London: Groombridge, 1846. 8vo. pp. 110; 43 lithographic plates.

This is a new edition of a work reviewed in a former volume of this Journal. The object of the treatise is confined to the explanation of the geometrical forms and position of the Voussoirs of Oblique Arches, and does not comprise the mechanical theory of these structures—the subject is in fact a particular branch of Descriptive Geometry. The three preliminary chapters treat of those principles of plane and solid geometry which are necessary to the explanation of the construction of oblique arches; the theory of which is divided into two portions—the theory of oblique arches, with spiral joints and that of oblique arches with plane joints, the distinction between the two kinds of arches is thus defined.

"*An oblique arch* with spiral joints, is that in which the surfaces of the beds and the surfaces of the joints are both spiral surfaces.

If an oblique arch with spiral joints be executed according to the principles here established, and cut by a plane perpendicular to the axis of the cylinder, the section will exhibit a series of straight lines, dividing the arc of a circle into smaller arcs, and the lines being prolonged, would meet in the centre.

An oblique arch with plane joints is that in which the beds of the stones are planes, passing through the axis of the cylinder. The planes of the joints being parallel to the axis, intersect each face of the arch in very oblique angles, and only one of the joints can be perpendicular to the face. All the other joints, as they recede from the centre, are more and more oblique till they reach the summit of the arch. As every oblique joint causes the angles made by the face and that joint to be very unequal, the obtuse angle will be much stronger than that which is acute, these angles being supplements of each other. Therefore oblique arches with plane joints should never be used where great strength is necessary; and where the angle of obliquity is very acute, the oblique arch with spiral joints should only be employed, as the spiral joints are as nearly perpendicular to the face as the construction will admit."

Of course in a work like this one of the first requisites is simplicity and precision of language. The difficulty of conveying by words (and even by diagrams) clear ideas of solid geometry can only be overcome by the most scrupulous adherence to the plain and uncomplicated modes of expression. Our author seems to have generally paid great attention to this point. Among the new portions of the present edition is a description of an oblique bridge over the river Gaunless, to which the following general observations are appended.

"To construct an oblique arch entirely of stone is, in some countries where it is difficult to procure, very expensive. However, in order to build one which will be sufficiently strong at a moderate price, it is necessary that the imposts or springings should be of stone, and, to have the appearance of good work, the quoins which form the ring-stones and the head of the arch should also be of stone. Then the intermediate parts of the courses may be of brick, (allowing perhaps four courses of bricks to each stone springer,) depending on thickness at the abutment. To work the springers and the quoin-heads, the same templets will be required as if the arch had been constructed entirely of stone. Previous to setting the brick courses, the boarding or laggings should be truly adjusted and fixed; and, for the regulation of the work, the bed-lines should be drawn thereon in their true position. In order to try the work as the bricklayer proceeds, he ought to use a kind of set-square, made of thin board, containing an angle exactly the reverse of the templet; and, consequently, the curved edge will be concave instead of being convex, as in the arch-square. The sides of each course being made to agree with every application of the set-square, will be what it ought to be. In stone courses, if the stones are truly wrought, the spiral surfaces of the beds will all agree with a set-square; and, therefore, in this case it will be unnecessary to provide one."

There are several useful trigonometrical tables appended to the work, in order that the mason may find in it all the information which he requires, without the trouble of referring to other books. The plates are well executed. At the end of the volume we regret to see several "testimonials regarding the success which the author has had in the application of his principles to the execution of oblique arches." These testimonials appear to be satisfactory in themselves, but they are out of place. Geometric principles are not patent medicines.

Concise Tables to Facilitate the Calculation of Earthworks required in the Construction of Railways, &c. By John Hughes, Engineer. London: Effingham Wilson. 1846., 12mo., pp. 26.

This is a very useful little book, and the portable form which it assumes is not its least recommendation. The object is to determine the volume of the solid formed by earthworks in cuttings and embankments.

There is this difficulty in determining this solid, that only one side of it is rectangular or of the same width throughout—namely, the plane surface of the roadway itself,, which, in embankments, is the highest, and in cuttings the lowest side of the prismoid; the other sides of this solid vary in all their dimensions, and though two sides opposite to each other may be of unequal areas. For instance, in a cutting which commences at the foot of a hill and terminates at a tunnel, the depth of the cutting gradually increases, so that the perpendicular face at the mouth of the tunnel is of greater area than the parallel vertical plane, supposed to be drawn at the base of the hill. The two oblique sides of the cutting also necessarily widen as they approach the tunnel. Opposite portions of them may also be unequal to each other, the depth of cutting to the right and left of the railway depending on the original form of the hill. Mr. Hughes takes a very simple method of ascertaining the solid content of the prismoid. He imagines it divided into numerous small portions by vertical planes parallel to the faces at the commencement or end of the cutting: so that, in fact, the solid is considered as made up of numerous thin *slices* of equal *thickness*, but varying in their vertical areas, which are trapeziums. It is clear, that by ascertaining the area of each of these trapeziums, taken at a certain determinate interval, the solid content of each *slice* may be determined by knowing its thickness; and, adding all the solid contents so found, we have the total volume of the cutting. The same method, of course, applies to embankments. It is important, however, to remark respecting the method here adopted, that the more numerous the cross sections are, the more closely will the result approximate to absolute accuracy.

It is clear also, that Mr. Hughes's method contemplates the case in which the upper side of the solid is *curved*. The tables hitherto published have referred only to the particular case in which the solid is bounded by *planes* only. The following extract may be introduced to show how far the present work differs from those of an analogous nature which have preceded it:—

In extensive works, such as railways and canals, the value of the earthwork is about one-fourth of the entire cost of construction; and, therefore we find that engineers have given their attention to correct the approximations with which, in past times, the parties were satisfied, as well who executed road and canal works, as their superintendents. The appearance of the elaborate tables of Macneill, and of those in a more condensed form attributed to Bidder, went far to eradicate the practice, almost universally prevalent, of taking average heights from a longitudinal section, or of averaging the areas of the cross sections; a practice recommended by its facility of application, and having nothing in its form, until reflection was bestowed upon it, to excite suspicion of erroneous results in the minds of those who were deeply interested in its truth. The damage to the interest of contractors, in point of quantity, was, however, in all probability no more than equivalent to the additional price paid to them for executing the work; but all arrangements which depended on balancing embankments and cuttings were frequently found to be unavailable, and the disappointments from this source were set down to a change of bulk in the material removed, which was assumed without sufficient examination, and which, until more competent persons took such arrangements into their own hands, covered the ignorance of the surveyors from the eyes of their employers.

Bidder's table requires that the longitudinal dimensions should be taken with a Gunter's chain, a standard never introduced in the drawings or specifications of the architect; and, as well as Macneill's tables, does not extend to heights greater than 50 feet, whilst cuttings occur on railways more than 100 feet in depth. At the entrance of tunnels they are rarely less than 70 or 80 feet, and embankments of 80 feet in height are not uncommon. I naturally, therefore, directed my attention to the means of obviating this inconvenience by employing the *general formula* for the content of a prismoid, of which Macneill gave a demonstration as applied to a restricted case, and upon which restricted case both his tables and Bidder's were calculated. The particular case taken by Macneill, is that of a solid bounded by a horizontal rectangular plane at the bottom; by two parallel, trapezoidal, vertical planes, of unequal heights, at the ends; by two trapezoidal planes, equally inclined, on opposite sides of the vertical, at the sides; and by a sixth plane at the top, passing through the parallel bases of the end trapezoid.

The Suspension Bridge at the Falls of Niagara.—It is proposed to construct a suspension bridge above the Falls of Niagara, so as to join the Canadian Railway and the United States. The execution of it is to be confided to Mr. Charles Ellett, of Philadelphia, or to Mr. John A. Roebling, of Pittsburg. Mr. Ellet lately visited the spot, for the purpose of examining the locality, and to ascertain the practicability of erecting so great a desideratum. There is a bridge which exists about a mile and a half below the cataract, and near the gulph, or whirlpool, where the distance of the two chief abutments, from one side to the other, does not exceed 640 ft. The expenses for constructing this bridge are estimated by Mr. Ellett at 43,200*l.*, for which sum he offers to build it, and he subscribes himself to the amount of 4,320*l.*

THE BROAD AND NARROW GAUGES.

Report of the Royal Commissioners.

May it please your Majesty,—We, the Commissioners, appointed by writ, under your Majesty's Privy Seal, bearing date the 11th of July, in the ninth year of your Majesty's reign, to inquire whether, in future private acts of Parliament for the construction of railways, provision ought to be made for securing an uniform gauge, and whether it would be expedient and practicable to take measures to bring the railways already constructed or in progress of construction, in Great Britain, into uniformity of gauge, and to inquire whether any other mode could be adopted of obviating or mitigating the evil apprehended as likely to arise from the break that will occur in railway communications from the want of an uniform gauge, beg dutifully to submit, that we have called before us such persons as we have judged to be, by reason of their situation, knowledge, or experience, the most competent to afford us correct information on the subject of this inquiry, and we have required the production of such books and documents from the various railway companies as appear to us to be the best calculated to aid our researches.

We have personally examined into the usual course of proceeding on various railways both at home and abroad, especially those which are incident to a break or interruption of gauge, and we have personally inspected several locomotive engines as well as mechanical contrivances invented, either for the general use of railways, or for obviating the special difficulties presumed to arise from the break of gauge, or otherwise connected with the subject of our inquiry, and as we believe we have now carried our investigation to the utmost useful limits, we feel in a position dutifully to offer to your Majesty the following report.

BREAK OF GAUGE.

1. Our attention was first directed to ascertain whether the break of gauge could be justly considered as an inconvenience of so much importance as to demand the interference of the Legislature.

Gloucester is the only place where a break of gauge actually exists at the present time. It is caused by the meeting at that place of the broad or 7 feet gauge with the narrow or 4 feet 8½ inch gauge. There are other points, however, where a transfer of goods occurs similar to that which must result from a break of gauge, and persons well acquainted with railway traffic have no difficulty in seeing the nature of the inconvenience that would arise from any further intermixture of gauge: and we humbly submit the observations that occur to us as to the whole of this important part of the question.

We will divide the subject of the break of gauge under the following heads:—

1st, as applying to fast or express trains; 2dly, to ordinary or mixed trains; 3dly, to goods trains, and 4thly, to the conveyance of your Majesty's forces.

1st. Fast or express trains.

We believe that the inconvenience produced by a break of gauge will, in some respects, be less felt in these than in other trains, because the passengers travelling by fast trains are usually of a class who readily submit to many inconveniences for the sake of increased speed on the journey, and who are perhaps generally less incumbered with luggage than persons travelling by the slower trains; and as it is understood to be the general practice that no private carriages or horses are conveyed by these trains, the inconveniences of a break of gauge are reduced in this instance to the removal of the passengers and a moderate quantity of luggage; and, although such removal must create delay and some confusion, as well as personal discomfort, especially at night and in the winter season, besides the risk of a loss of luggage, yet we do not consider the break of gauge, in this instance, as being an inconvenience of so grave a nature as to call for any legislative measures, either for its removal or for its mitigation.

2dly. Ordinary or mixed trains.

In these trains the passengers considerably exceed in number those who travel by the fast trains, and they have generally a much greater quantity of luggage. To such travellers a change of carriage is really a serious inconvenience, and it is a well known fact that persons travelling by railways in communication with each other, but under different managements endeavour to make such arrangements as to admit of their travelling by those trains which afford them the accommodation of occupying the same carriage from the beginning to the end of their journey.

The managers and directors of railways are well aware of this feeling, and in some instances where they do not allow their carriages to run through, yet with a view of diminishing the inconvenience to which this exposes their passengers, they send a luggage train from terminus to terminus, to prevent the evil of a removal of the passengers' luggage; and some railway companies incur considerable expense in running trains of return empty carriages, in order to accommodate the public by enabling travellers to avoid a change of carriage on the journey.

It is by the ordinary or mixed trains that private carriages and horses are conveyed, and the removal of either from one truck or horse-box to another, at any part of the journey, would be attended with inconvenience and delay; and with regard to the horses, it would involve considerable risk.

We arrive, therefore, at the conclusion that the break of gauge would inflict considerable inconvenience on travellers by the trains now under consideration, and that this inconvenience would be much increased at points of convergence of more than two lines.

The change of carriages, horse-boxes and trucks, and the transference of luggage of an entire train of much extent, must even in the day time, be an inconvenience of a very serious nature, but at night it would be an intolerable evil, and we think legislative interference is called for to remove or mitigate such an evil.

3dly. Goods trains.

From the statements made to us by carriers on railways, and from our own observation, we are induced to believe, that not only a considerable degree of care, judgment, and experience is necessary in the stowage of merchandise in railway wagons, but also, that it is desirable that when properly packed the articles should, generally speaking, not be disturbed until the journey is completed. We find that in the arrangement of merchandise, the heavier goods are placed at the bottom, and the lighter at the top of the load, and so secured as to prevent friction as far as practicable from the jolting of the wagons; and it is considered very desirable, with a view to prevent loss by pilfering, that the sheeting, which is placed over the load, should not be removed till the completion of the journey. Indeed, acting upon this principle carriers find it profitable to send their wagons partially filled from various stations on the line, thereby increasing their toll to the railway company, rather than incur the risk of loss by theft, to which they would be exposed by uncovering the wagons on the journey to fill up with intermediate local goods wagons that may have started with light loads from one of the termini.

The stations for re-arranging the goods trains are therefore as few as possible; thus, between Leeds and London, the points for unsheeting the goods wagons are only Derby and Leicester, and between Liverpool and London, the re-arrangement is confined to Birmingham and Rugby; and even at those stations the proportion of wagons which are uncovered is very small: indeed, it is stated that at the important town of Birmingham five-sixths of the wagons pass without re-arrangement.

In the conveyance of machinery and articles of a similar class, which are both heavy and delicate, it is of the utmost consequence that the load should not be disturbed between the beginning and the end of the journey; a change of carriage, such as would result in all probability from a break of the gauge, would altogether prevent the transport of such articles by this mode of coveyance.

We believe that the traffic upon the line of railway between Birmingham and Bristol has been greatly restricted by the interruption of gauge at Gloucester.

In respect to the conveyance of minerals, the inconvenience of a break of gauge would be very serious; the transfer being attended with an expense which would be sensibly felt in consequence of the low rate tolls charged on such articles; moreover, many descriptions of coal, such as a considerable proportion of that of the Midland Counties, are subject to great deterioration by breakage.

In regard to various articles of agricultural produce, the loss by removal would be less than on other classes of goods; much inconvenience, however, would be found in the transfer of timber; and the difficulty of shifting cattle would be so great as to present an insurmountable obstacle to such an arrangement, from the excited state of the animals after travelling by railway, and the resistance they in consequence offer when it is attempted to force them a second time into a railway wagon.

4thly. Conveyance of Troops.

There is another use of railways which we have deemed it necessary to consider; we allude to the transport of your Majesty's troops, with their military stores, &c., either in the ordinary movement of corps through the country in the time of peace, or in the more pressing and urgent case of their movements for the defence of coast or of the interior of the country.

We have carefully weighed the important information given to us by the Quartermaster-General of your Majesty's Forces, as well as by the Inspector-General of Fortifications, both officers of great experience; and we deduce from their opinions, that although a break of gauge on the line of route would produce both delay and confusion, yet that, as in time of peace it is usually practicable to give notice of the intended movements of a body of troops, the inconvenience of the break of gauge might be so reduced as not to be an evil of great importance; but, in the event of operations for defensive objects against an enemy, the inconvenience would assume a serious character.

It would appear, that for the defences of the coast, the proper course would be to retain the great mass of troops in the interior of the country to wait until the point selected by the enemy for his attack should be ascertained with certainty, and then to move upon that point such an overwhelming force as should be adequate to the emergency.

It is obvious that the success of such a system of defence must depend upon the means of conveying the troops with great dispatch, and without interruption on the journey.

The troops should be carried with their equipments complete in all their details, and with their artillery and ammunition; and it therefore appears indispensably necessary, in order to insure the requisite supply of carriages where perhaps little or no notice can be previously given, that the whole, should be conveyed in the same vehicles from the beginning to the end of the journey.

The effect of a break of gauge might in this view of the case expose the country to serious danger.

To all classes of merchandise, as well as to all military operations connected with railways, one general remark will apply, that in starting from any one point it is usually practicable to obtain a sufficient number of wagons for whatever may be required to leave that point, however irregular the traffic may be; but, at the convergence of several lines, where the greater number might be of a gauge not corresponding to the gauge of the other lines, if it happened that all were unusually loaded at the same time, it would probably be impossible to provide on the latter an adequate number of wagons to carry off all the loads thus brought; the alternative would be, on the one hand, to submit to great confusion, delay, and inconvenience, on all the converging lines having the majority on the same gauge; or, on the other hand, to maintain on the lines being in the minority a very extensive stock of carriages, which in general would be totally useless.

There is one point which forcibly presses on our attention, and the truth of which must be readily acknowledged, but of which the importance is not at first equally obvious; it is, that the greater part of the inconveniencies to which we have alluded are not inconveniencies of rare occurrence, and which would affect only a small number of persons, but, on the contrary, that many of them would occur several times in the course of every day to a great number of persons at each point at which a break of gauge might exist. The cumulative amount of such inconvenience would of necessity be very considerable, and we feel bound to sum up our conclusions by stating that we consider a break of gauge to be a very serious evil.

II. Mechanical means of transference from one Gauge to the other.

We are now brought to the second stage of our inquiry, which is, to discover the means of obviating or mitigating the evils that we find to result from the break of gauge.

The methods which have been laid before us, as calculated for this purpose, are as follows:—

1. What may be termed telescopic axles; an arrangement of the wheels and axles of carriages, permitting the wheel to slide on the axle, so as to contract or extend the interval between them in such a manner that they may be adapted to either of the gauges.

2. A form of truck adapted to the broad gauge, but carrying upon its upper surface pieces of rail 4 feet 8½ inches asunder, so that a narrow gauge carriage may be run upon these rails without any disturbance of its wheels.

3. A method of shifting the bodies of carriages from a platform and set of wheels adapted for one gauge, to a different platform and set of wheels adapted to the other gauge.

4. A proposal to carry merchandise and minerals in loose boxes which may be shifted from one truck to another and of which only one would probably be carried upon a narrow gauge truck, while two would be conveyed on a broad gauge truck.

1. Telescopic Axles.

Of these various methods, the first—if it admitted of being used safely and extensively—would be, in its application, the easiest of all.—By the operations of detaching the wheels from one limiting hold, of pushing the carriage along converging or diverging rails, until the wheels were brought to the required width, and of then connecting them by another limiting hold, the transformation of the narrow gauge carried to the broad gauge carriage, or *vice versa*, would be completed. But this construction is liable to grave objections. It is stated to us as a matter of experience (and we believe it admits of satisfactory explanation), that very small unsteadiness of the wheels of a railway carriage upon the axle renders the carriage liable to run off the rails. A far more serious objection, however, is, that the safety of a carriage and the whole train with which it is connected would depend upon the care of the attendant, who has to make the adjustment of the axle-slide.

It is true that there are other cases, as in the attendant on the switches and signals, which depend upon the care of the person who is stationed to work them: but the circumstances differ very widely. In these cases the attendant has a single act to perform (or at the utmost, two acts only,) he is not hurried, and his whole attention is concentrated on very simple duties.

In respect to the shifting axles, the attendants would have to adjust a great many carriages in succession (as there are sometimes a hundred wagons in a goods train), the adjustment must be made hurriedly, and often in the night; and the attendant's thoughts would probably have been partly occupied with the loading of goods and other station arrangements.

On the score of danger, therefore, we think that the construction must be at once abandoned. But we think it proper to add, that even if there were no such essential ground of objection, a construction of this nature could not be adequately useful unless it were extended to every carriage which is likely to pass the station where the break of gauge occurs. Under the existing system of interchange of carriages, which is adopted by all the railway companies whose lines communicate, and of which the advantages are recognised in special clauses of the acts of Parliament applying to several railways, carriages belonging to distant railways will frequently be found a the place of junction of the two gauges. This construction therefore, would lose much of its utility unless every railway carriage were made in conformity to it, that is, unless a vast expenditure of capital, and a corresponding annual expense in replacing worn-out carriages, &c., were incurred even on railways very distant from the break of gauge.

2. Shifting Narrow Gauge Carriages on to Broad Gauge Trucks.

2. The plan of placing a narrow gauge carriage upon the top of a broad gauge truck has, on the face of it, this obvious difficulty, that a broad gauge carriage cannot be placed in the same manner upon a narrow gauge truck, and therefore, unless not only the broad gauge railway, but also as others communicating with it, be furnished with trucks proper for carrying narrow gauge wagons, and with narrow gauge wagons also, and unless the loads travelling towards the narrow gauge be placed only in these narrow gauge wagons, the system effects nothing as regards the passage in one direction. But even with regard to the passage from the narrow gauge to the broad gauge, the system will not bear examination. If the trucks are supported on springs, there is practically a difficulty in running the wagons upon them; and if they are not supported on springs, they will sustain great injury on the journeys. If they are loaded singly there will be a great delay; if they are placed in a row, and the narrow gauge carriages are run through the whole series, very great caution will be necessary to secure each carriage both in front and in rear. When heavy loads are thus placed in elevated positions, and when the security of each depends upon adjustments hurriedly made, there will be the danger to which we have alluded in noticing the first proposed construction. Finally, an enormous amount of dead weight will be carried on the broad gauge line. We reject this proposal as entirely inapplicable to the traffic of railways.

3. Shifting the bodies of carriages from one set of wheels to another.

3. The system of shifting the bodies of carriages from road wheels to railway wheels is practised successfully in France, where the diligences from Paris to distant towns, proceeding on road wheels from the Messagerie of Paris to the railway station, are carried on a peculiar railway truck as far as Rouen and Orleans, and are then again placed on road wheels to continue their journey. At the low speeds of the French railways this system is safe, but we doubt whether it would be safe with the speeds of the English railways. Moreover it deprives the railway system of one of its greatest conveniencies; namely, its readiness to receive almost any number of passengers without warning, and to carry them to any distance, small or great. Carriers' carts are also conveyed (but to no great amount) in the same manner. In France, as we understand, it is not thought likely that the system will be in any degree retained when those railways shall have been extended further. The same remarks, we conceive, would apply entirely, or in a great measure, to similar proposals for the shifting of the bodies of railway carriages; but as this plan has never been strenuously urged, it is unnecessary to criticise it more minutely.

4. Conveying Goods in Loose Boxes.

The system of conveying goods in loose boxes, carried upon railway trucks, has been seriously discussed. It has been repeatedly tried, and we are able therefore to give an opinion on it, founded on experience.

The result of this experience is, that in one instance of a temporary character, where the whole operation was under the control of one engineer, it succeeded, in other instances, although always under the control of one engineer or one company, it has usually failed; and these failures have occurred where from the deterioration, caused by hand-shifting, to the mineral conveyed, it was matter of anxiety to avoid transference of the load from one box or wagon to another, and where no expense was spared in the erection of machinery proper for the transference of the loose boxes.

These failures, it is to be remarked, occurred in a traffic which is comparatively regular, viz., that of coal; in traffic of a less regular character the causes tending to produce failure would be very much more numerous.

We consider that this method is totally inapplicable to remedy the inconveniencie of a break of gauge.

Some of the witnesses whom we have examined are of opinion that there would be less difficulty in unloading the wagons of one gauge, and placing the articles in wagons of the other gauge, by having two rows of wagons on the different gauges, marshalled alongside of each other; but having witnessed this process at Gloucester, we are of opinion that such a system is totally inapplicable to an extended traffic.

We sum up our conclusion on this head, by stating our belief that no method has been proposed to us, which is calculated to remedy in any important degree the inconveniences attending a break of gauge.

III. Policy of Uniformity of Gauge.

Considerations on the general policy of establishing an uniformity of gauge throughout the country.

We approach this momentous question with a full conviction of its importance, and the responsibility that rests upon us.

That an uniformity of gauge is now an object much to be desired, there can, we think, be no question. In the earlier period of the railway history of this country the great trunk lines were so far separated as to be independent of each other, as it were, isolated in their respective districts, and no diversity of gauge was then likely to interfere with the personal convenience or the commercial objects of the community; but now that railways are spreading in all directions, and becoming interlaced with each other in numerous places, that isolation is removed, that independence has ceased, and the time has arrived when, if steps cannot be taken to remove the existing evil of the diversity of gauge, at least it appears to us imperative that a wider spread of this evil should be prevented.

If we had to deal with a question not affecting the interests of parties, who are not only unconnected, but who are opposed to each other in a spirit of emulation, if not of rivalry; or if we were dealing with the property of the public, and not of private trading companies, we should merely have to consider whether that uniformity of gauge which we deem to be so desirable would be to dearly purchased by an alteration of one gauge to suit the other, or of both to some fresh gauge which might be considered preferable to either, if any such there be.

But our position is different from this, since we have to consider not only the relative length of the different systems, the comparative mechanical efficiency of each, the general superiority of one above the other, their adaptation to the wants of the country, and the possibility as well as the policy of a change, but also the pecuniary means of effecting it. We have further to ook to the consequences of an interruption of the traffic during the progress of an alteration.

Double Gauge Railways.—There is still another view of the question, and that is, the expediency of having, on lines of railway, additional rails, so as to afford the facility of using engines and carriages on both gauges.

This expedient, in whatever form adopted, cannot be considered as free from difficulties. If two rails, forming a narrow gauge way, are placed between the two rails which form a broad gauge way, carriages of the different gauges may run in the same train, without alteration even of their buffers, which in the ordinary construction of the carriages correspond exactly on the broad and narrow gauges. But the expense of such an insertion would probably be not less than that of an entire change of gauge, including in the latter, the change of engines and carrying stock; and the complication which it would introduce at the crossings might produce danger to rapid trains, unless their speed were diminished at approaching such points. The difficulty of packing the rails, if longitudinal sleepers were used, would also be much greater than if rails of only a single gauge were employed. If a single rail were inserted eccentrically in a broad gauge way, so as to form, in conjunction with one of the broad gauge rails, a narrow gauge way, the expense of the insertion, and the danger of the crossings, as well as the difficulty of packing the rails, would be somewhat diminished, but it would be imprudent to run carriages of the different gauges in the same train, and as it would probably be the policy of the railway company to adopt for their own stock of engines only one of the two gauges, and to interpose these difficulties which amount to a prohibition of the use of other companies' engines, the inconveniences of a break of gauge would exist in almost all their force at every junction of a branch railway on a different gauge.

We consider, therefore, that the general adoption of such a system ought not to be permitted.

We remark however, that the difficulties to which we have alluded may be greatly diminished on any railway where the system of combined gauges is cordially taken up by the company; and we think that great respect ought to be paid to the rights which the companies may be supposed to possess in the methods or systems which they have devised or adopted. At the same time, we lay it down as the first principle, that inter-communication of railways throughout the country ought, if possible, to be secured. If, to obtain the last-mentioned object, it should be necessary to alter or make a change in any existing railways, we think that it may be left as a matter of ulterior consideration for the Legislature, whether in these limited instances the combination of gauges may not be allowed.

Whatever may be the course which at the present time circumstances will permit, it will appear from the opinion we have expressed, that we think, abstractedly equalization desirable; and we shall therefore proceed to consider what gauge would be the best in such a system of equalization.

We shall examine this part of the question under the following heads:—
1. Safety.—2. Accomodation and convenience for passengers and goods.—
3. Speed.—4. Economy.

1. Comparative Safety.

We are of opinion that experience will, in this matter afford a better test by which to compare the systems of the broad and narrow gauge than any theory; and we therefore have made inquiry into the nature of the accidents recorded in the official reports of the Board of Trade, as well as of such as have happened since the last report was published.

We find that railway accidents arise from collisions, obstructions on the road, points wrongly placed, slips in cuttings, subsidence of embankments, a defective state of the permanent way, loss of gauge, broken or loose chairs, fractures of wheels or axles, &c.; and, lastly, from engines running off the line from some other cause.

Of these several classes of accidents, all except the last are obviously independent of the gauge; and with reference to this last class, we have thought it right to endeavour to determine whether the advocates of either gauge could fairly claim, in regard to these accidents, a preference for their respective systems, on the score of greater security to the traveller. In these lists we find only six accidents of the kind we are considering recorded from October, 1840, to May, 1845, whereas there have been no less than seven within the last seven months, and these are attributable to excessive speed, the majority having happened to express trains. Of the whole number of these accidents, three have occured on the broad gauge and 10 on the narrow; the former, however, differ in their character from the latter, the carriages only, in the last two cases, having been off the line, whereas, in all the 13 narrow gauge cases, the engines have run off, and the consequences have been more fatal. We must here observe, however, that the extent of the narrow gauge lines is 1,901 miles, and that of the broad only 274; therefore the comparison would be unfavourable to the broad gauge if considered merely with regard to their relative length; but it must be borne in mind that the general speed of the Great Western considerably exceeds that of many of the narrow gauge lines, and that some consideration is on that account due to the broad gauge.

The primary causes of engines getting off the rails appear to be over driving, a defective road, a bad joint, or a badly balanced engine. If, in consequence of heavy rains or other unfavourable circumstances, any part of the road becomes unsound, the engine sinks on one side as it passes along such part of the rail, suddenly rises again, and is thus thrown into a rocking and lateral oscillatory motion, with more or less of violence according to the rate of speed, and a very similar effect is produced in passing at high speeds from one curve to another of different curvature. A succession of strains is thus thrown upon the rails, and if, before the rocking subsides, the wheel meets with a defective rail or chair, which yields to the impulse, the engine and train are thrown off as a necessary consequence; but, as far as we can see, such casualities are equally likely to happen on either gauge, other circumstances being similar.

It has indeed been stated by some of the witnesses whom we have examined, that the broad gauge is more liable to such accidents, from the circumstance that the length of the engine, or rather the distance between the fore and hind axle, is less in proportion to its breadth than in the narrow gauge engines, and that therefore the broad gauge engine is liable to be thrown more obliquely across the lines, and in case of meeting with an open or defective joint, more liable to quit the rail; but we cannot admit the validity of this objection against the broad gauge lines. It may be that the proportion between the length and breadth of the engine has some influence on its motion, and that the motion is somewhat less steady where the difference between the length and breadth is considerably diminished; but practical facts scarcely lead to the conclusion that the safety of the trains is endangered by the present proportion of the broad gauge engines; for it appears that on the London and Birmingham Railway, where the engines hitherto employed have been, generally, short four-wheeled engines, the distance from axle to axle not exceeding 7 feet, or 7 feet 6 inches, no such accident as we are considering has been reported; and we are informed by Mr. Bruyeres, the superintendent of that line, that no such accident has ever occurred. The same remark applied to some other narrow gauge lines; and if, as has been stated, exemption from these accidents has resulted from the close fixing of the engine and tender adopted on this line, the same system might be adopted on any other line, whether on the broad or narrow gauge. An evil may also sometimes arise in six-wheeled engines, by the centre of gravity of the engine being brought too much over the driving wheels, and the springs being so adjusted for the sake of the adhesion of the wheels to the rails, that the front wheels would have little or no weight to support, and would be thus in a condition, by any irregularity in the road or other obstruction, to be more easily lifted off the rails. But here again, if this fault in the construction or adjustment has been anywhere committed, it is a fault or defect wholly unconnected with the breadth of gauge.

Another cause of unsteady or irregular motion, dangerous to the safety of the train has been stated to be the great overhanging weight beyond the axles of some engines of recent construction, and of the weight of the outside cylinder beyond the axle bearings. So far as this construction is concerned, it certainly appertains to narrow gauge lines only; but at the same time we must remark, that it is not essential to their working.

Upon the whole, therefore, after the most careful consideration of this part of the subject, we feel bound to report, that as regards the safety of the passenger no preference is due, with well proportioned engines, to either gauge, except perhaps at very high velocities, where we think a preference would be due to the broad gauge. On this part of the subject we would beg to point to the nature of the evidence of Mr. Nicholas Wood.

Relative Accomodation for Passengers and Goods.

Passengers.—The first-class carriages of the broad gauge are intended to carry eight passengers in each compartment, and the compartments are sometimes subdivided by a partition and inside door. On the narrow gauge lines the first-class carriages are usually constructed to carry only six passengers in each compartment; and we find that about the same width is allowed for each passenger on both gauges. Some of the original mail carriages were adapted for four passengers, and we believe that the public had a preference for these carriages over both the other descriptions.

Until lately the broad gauge carriages were altogether more commodious than those of the narrow gauge, but recently carriages have been introduced on several of the narrow gauge lines nearly as lofty as those on the broad gauge, and equally commodious; in short, we now see no essential difference as regards accommodation and convenience to individual passengers in the first-class carriages of the two gauges.

In the second-class carriages on the broad gauge, six-persons sit side by side, each carriage being capable of holding 72 passengers. On the narrow gauge generally, only four passengers sit side by side, the total number in each carriage being 32; in this respect we are inclined to consider the latter are more comfortably accommodated.

With reference to the ease of the carriage, and the smoothness of the motion, we have had very contradictory evidence, and it must be admitted that great difference is experienced on the same line at different times, depending upon the state of the road, the springs of the carriage, the number of persons in a carriage, to bring the springs into action, the position of the carriage in the train, and the speed at which the train is propelled, of all which conditions are independent of the breadth of the gauge. We have however, with a view of making our observations on this question, travelled several times over all those lines having their stations in London, and after making, to the best of our judgment, every allowance for the circumstances above-mentioned, we are of opinion that at the higher velocities the motion is usually smoother on the broad gauge.

Merchandise.—It is now to be considered whether either gauge has a superiority over the other in regard to the conveyance of general merchandise.

Under this head we class manufactured goods and their raw material, mineral products, such as coal, lime, iron, and other ores; agricultural produce, such as corn, hops, wool, cattle, and timber.

On these points we have taken the evidence of persons well acquainted with the carrying trade, and from their information, and our observation, it does not appear to be of consequence to the parties sending or receiving goods whether they are transmitted in wagons containing five or six tons, or in wagons of larger capacity, provided that the cost and security are the same, and that the carriers undertake the responsibility of any damage that may result from the size of the load. But Messrs. Horne and Chaplin, and Mr. Hayward, who are largely interested, and have had great experience in the carying trade, have expressed a strong opinion that the smaller wagon is far the more convenient and economical. The same opinion is still more strongly expressed by those witnesses we have examined who have experience of our mineral districts. These persons state that the smaller wagon can be more easily handled, and can be taken along sharper curves than would be suited to a broader wagon; that such sharp curves are very common in mineral works and districts, and that the broken nature of the ground would render curves of greater radius inconvenient and expensive.

Another important difference between the two gauges, in this commercial view of the question, would present itself in localities in which there may be a difficulty of readily obtaining full loads for the wagons at road stations. Here the defect of the dead weight, which we find to apply more particularly to the broad gauge, would be greatly increased unless another evil of still greater commercial importance were created, that of detaining the wagons to receive full loads. On the whole therefore, we consider the narrow gauge as the more convenient for the merchandise of the country.

2. Relative Speed.

With a view to form our judgment on this subject, we have examined the time-tables of the several companies having express and fast trains, and the returns furnished by those companies of the actual speeds attained by the express trains, on 30 successive days, from the 15th of June to the 15th of July, 1845.

We have also, on various occasions, travelled in the express trains, and noted the speed, mile by mile.

The result has been, that we are fully satisfied that the average speed on the Great Western, both by the express trains and by the ordinary trains, exceeds the highest speed of similar trains on any of the narrow gauge lines. But some of the latter have trains which exceed in speed the corresponding trains of the Bristol and Gloucester line, and also of the Swindon and Gloucester line, both of which are on the broad gauge; but these latter, it is to be remembered, are still of recent construction with unfavourable curves and gradients; and we have been informed by Mr. R. Stephenson, in his evidence, that at one period the speed on the Northern and Eastern line even exceeded that of the Great Western.

In treating of a difference in the speed, other circumstances besides the mere gauge must be considered. The inclinations and curves of the Great Western Railway, between London and Bristol, and even for 40 miles beyond Bristol, are, with the exception of the Wootton-Basset and the Box inclines, particularly favourable to the attainment of high velocities; and it is important to remark, that the inclinations and curves on that part of the Northern and Eastern Railway where the competition in speed with the Great Western was the most successful are generally of a similar character.

One of the principle motives professed for constructing the Great Western Railway on the broad gauge was the attaining of high speeds, and the credit of the proposers and defenders of that construction has therefore been deeply engaged in maintaining them.

The effect of gradients on the speed of the Great Western trains, even with the powerful engines used on that line, is shown in the Time Table, page 24, where we find that while the speed from Paddington to Didcot by the express train is $47\frac{1}{2}$ miles per hour, from Didcot to Swindon it is only 41·1, and from Swindon to Gloucester only 31·7; from Swindon to Bath it is 46·2, but returning only 37·2: from Bristol to Taunton the speed is 46·3, and from Taunton to Exeter only 39·2.

Possibility of Future Increase of Speed.—We must observe, however, that while the Great Western Company have not altered in any degree the plan of their engines, the higher velocities of the narrow gauge lines have been attained by the introduction of a more powerful kind of engine than was employed at an earlier period, and probably the new engines now used on the narrow gauge are as powerful as they can well be made within the limits of their gauge; whereas the broad gauge lines have still a means of obtaining an increase in the power of their engines, and of increasing their speed, providing the road be in a condition to sustain the great increased force which must result from any increased weight of the engine moving at such high velocities.

Whether the permanent way is in such a state at present is very questionable, or even whether it be posible in all vicissitudes of weather to maintain it in such a condition. We ought not to lose sight of the fact, that since the introduction of express trains the accidents arising from engines running off the line have been much more common than in former years; indeed, these accidents have been more numerous within the last seven months than within the preceding five years, and it is questionable whether this contest for speed ought to be carried to any greater length. We are, indeed, strongly inclined to the opinion stated by several engineers in their evidence, that it is the stability of the road, and not the power of the engine, that will prescribe the limits of safe speed.

On the first introduction of passenger railways, speeds of about 12 miles per hour only were anticipated; the rails then employed weighed only 35 lb. per yard, and the engines about six or seven tons. As soon as speeds of 20 and 24 miles per hour were attempted, it was found necessary to have rails of 50lb. per yard, and engines weighing 10 and 12 tons. Since that time the rails have been increased in weight progressively to 65lb., 75lb., and 85lb. per yard, and the weight of the engine on the broad gauge exceeds 22 tons, and on the narrow gauge it now approaches 20 tons; indeed, we have seen a narrow gauge engine on six wheels weighing 30 tons. We doubt, however, whether a corresponding stability has been attained in the road itself.

Outside Cylinder Engines.—Amongst other changes for increasing the power of the engine and the speed of the trains of the narrow gauge lines there have been the giving an increased length to the engine, and the placing the cylinders on the outside of the framing; but it is the opinion of some of the witnesses we have examined, that this position of the cylinder has a tendency to produce a greater wear and tear of the journals, and a consequent rocking and irregular motion of the engine on the line. This, however, while the engine is of medium length, has been denied by Mr. Locke, who has had great experience in the working of outside cylinder engines. But it is stated by Mr. Gray and Mr. Gooch, that where the length of the engine is greatly increased, this increased length, by causing the extremities of the engine to overhang very considerably the fore and hind axles, has a great tendency to increase the irregular motion produced by the outside cylinder.

Mr. R. Stephenson admits that in some of the later engines this irregularity does exist, but he attributes it to the weight of the piston and its appendages, observing, "I do not believe that it is the steam that causes the irregular action, but I believe it to be the mere weight of the pistons themselves, and therefore if we could contrive to balance the piston by the weight upon the wheels, we should get rid of that very much."

At all events, from whatever causes the motion may arise, the oscillations are very considerable in some of these long engines, and such as can scarcely be considered safe at high velocities.

This great length of engine is, however, by no means essential to the attainment of high speeds on narrow gauge lines.

We found by timing the express trains on four different journeys on the South Western line, in both directions, that the whole distance was performed very satisfactorily in about 1 hour and 52 minutes, including the time of two stoppages, being at an average rate of 41 miles per hour, on a line which, in one direction, rises for a length of more than 40 miles on a very prevailing gradient of 1 in 330; and in the other rises for several miles on a gradient of 1 in 250. On each occasion a distance of five miles, on a level part of the road, was passed at the rate of 53 miles per hour.

The length of the engine boiler was only eight feet seven inches, the driving wheels six feet six inches in diameter; the leading wheels had both inside and outside bearings. The diameter of the cylinder in one case was 15 inches, in the others $14\frac{1}{2}$ inches, both outside, and attached to the smoke-box.

Evaporative Power of Broad and Narrow Gauge Engines.—In proceeding to compare the locomotive engines, we remark, in the first place, that the fire-boxes, boilers, &c., of the narrow gauge engines still possess a smaller evaporating power than those of the broad gauge engines, although recent attempts have been made to raise the former to the level of the latter; but those attempts have not succeeded; and it is indisputable, that whatever can be done for the narrow gauge, in this respect, can be surpassed on the broad gauge. And we concur in opinion with many of the ablest engineers, who have stated, that the engines of both gauges have nearly obtained the speed and power which it would be justifiable to employ in reference to the present strength of the rails and the firmness of the earthworks.

Diameter of Driving Wheels.—We remark, in the next place, that the diameter of the driving wheels of the broad gauge engines is greater than than that of the driving wheels of the narrow gauge engines, and, although, in many of the narrow gauge engines the use of the external cylinder has enabled the manufacturers to bring the boilers nearer to the driving wheel axles, and has thus permitted an increase of the diameter of the wheel, still it is always in the power of the constructors of broad gauge engines to make a corresponding change, and thus to maintain the superiority; for the larger diameter of the wheel is unquestionably favourable to high speed, both because the steam is used to greater advantage, and because the alternating shocks upon the machinery are less rapid. It is, however, extremely difficult to say at what speeds this advantage becomes appreciable. We think it likely, that as far as the speed of 40 miles an hour, there is no great difference between the two, but that for speeds of 50 or 60 miles an hour the difference may be worthy of notice. It becomes important, then, to inquire what may be the greatest speed that will probably be desired or maintained on railways for ordinary purposes.

It is certain that the wishes of the public will be limited only by considerations of economy and safety. The greater the speed the greater will be the cost; and it appears to be the opinion of many of the officers of railways, that it would be difficult to maintain with safety the present express speeds upon the great trunk railways.

The chief impediments to maintaining the present express speeds are—

1. The difficulty of arranging the trains, where the traffic is frequent, so that the first trains shall be entirely protected from the chance of interfering with or coming into collision with the slower trains, or those that stop at numerous stations.

2. The difficulty of seeing signals, especially in foggy weather, in time to enable the engine-driver to stop the fast trains.

We feel it a duty to observe here, that the public are mainly indebted for the present rate of speed, and the increased accommodation of the railway carriages, to the genius of Mr. Brunel, and the liberality of the Great Western Railway Company.

As regards the applicability of the atmospheric principle of traction, or of any other principle differing from the locomotive, we see no difference between the two gauges.

4. *The Question of Economy.*—Under this head we have to consider the cost of construction, the purchase of the plant, which consists of engines, of carriages, and of other carrying stock; and lastly, the cost of working.

There can be no question that, in the first construction of a railway, the narrower the gauge, the smaller will be the cost of the works. This applies to tunnels, bridges, viaducts, embankments, cuttings, sheds, workshops, turn-tables, transverse sleepers, and ballast, and the purchase of land; but it does not affect the rails, fences, drains, and station-houses. The exact difference, however, must depend in a great degree upon local circumstances, and no opinion can be given of the precise ratio of difference without going into a very minute calculation of each line on which the two systems are to be compared; for instance, in a line free from tunnels or viaducts, and in a flat country, where there are neither cuttings nor embankments, the difference would be limited very nearly to the quantity of land to be purchased (the severance and damage being about equal in both cases), the amount of ballasting, and some increase in the cost of the sleepers; whereas, in a very undulating country, the difference would be more considerable.

As to the cost of the maintenance of way, supposing the construction to be the same, that of the broad gauge must be rather the greater of the two.

Cost of Locomotive Power.—In respect to the cost of the engines and carrying stock, we have to observe that they are generally more expensive on the broad than on the narrow gauge. But, on the other hand, it is asserted by the advocates of the broad gauge system, that as the engines will draw greater loads, as the carriages will accommodate a greater number of passengers, and as the wagons are capable of conveying a larger amount of merchandise, the work can be, and is done, at a less charge per ton, and that a compensation is thus obtained for the increased outlay. How far this is found to be practically the case is the next subject for inquiry.

We were very desirous, if it had been found possible, thoroughly to investigate this part of the subject by means of the official data called for by us, and furnished by some of the principal companies, containing a statement of their working expenses; but we find the circumstances so different, that very little satisfactory information can be thus obtained, that has been obtained, that has strictly a reference to the economy of the two gauges. There are, of course, various matters that have an influence on the actual cost of locomotive power and general traffic charges, that are in no way connected with the breadth of gauge; such as the nature of the curves and gradients, the price of coke, the general nature of the traffic, the mode of working that traffic as adopted by different companies, the employment of engines of greater or less power, that increased accommodation to the public which involves an extra expense for return carriages, &c.

The London and Birmingham, and the Great Western Railway, as metropolitan lines of great traffic and of considerable length, would at first sight appear to furnish the best means of comparison, and there is, in fact, no difficulty in comparing the actual expenses; but these lines differ essentially in the character of their gradients and in the amount of traffic, estimated at per mile, and, above all, they differ in the character of the engines they employ.

Four Wheel Engines.—The London and Birmingham Company have, from the commencement, persevered in the use of light four-wheeled engines, while the Great Western, availing themselves of the facilities their gauge affords, have adopted large and powerful engines, which are worked at nearly the same cost per mile as the former; and if such engines, as those on the London and Birmingham line, were essential to the narrow gauge, the question, as to the economy of working, might be at once decided in favour of the broad gauge; but this is by no means the case; several narrow gauge lines employ engines of great power, and work, in consequence, much more cheaply than the London and Birmingham; therefore, the comparison between the working expenses of this line and of the Great Western can only be considered as a test of the principle of working with light and with heavy engines, and not as furnishing a test of the working economy of the two gauges.

It is a common practice with different railway companies, in their half-yearly reports to their proprietors, to state the per centage of their various expenses, under a few distinct heads, as compared with their revenue; and from these it appears that on the Great Western, the locomotive charges, during a period of three years, have varied between 8.8 and 11.1, averaging 9.7 per cent on their income, and on the London and Birmingham they have varied, within the same period, between 7.0 and 9.36, averaging about 8·6 per cent. on their income; and, therefore, on a superficial view of the question, the London and Birmingham would appear to have worked their line at a cheaper rate; but valid objections have been made to this comparison on the part of the Great Western; because it is obvious, from the several returns we have received, that the London and Birmingham Company has far the more abundant traffic per mile, and ought, therefore, to be expected to perform its work at a less per centage on its income. It has been stated by Mr. Gooch, that as locomotive superintendent on the Great Western, he is called upon to supply a certain amount of locomotive power, and that the cost of such power is almost entirely irrespective of the load or number of passengers it is made to draw; but that these numbers are of great importance in comparing the locomotive expenses with the revenue.

In page 27 of the appendix to this report, an abstract and comparative table are given, founded on returns furnished by the Great Western and London and Birmingham Railway Companies, showing that the revenue derived from the passengers' train is 64 per cent. greater per mile worked, on the latter than on the former line. It must, therefore, be obvious that, as a test of economy for working, we cannot adopt the principle of a per centage on the revenue, neither will the cost per mile run give a more just comparison as to the economy of the two systems, because it is a well-known fact that the London and Birmingham Company have been conveying their traffic with engines of inadequate power, and that great economy would result to them by the adoption of larger engines.

Other difficulties also occur in the comparison of these expenses on different lines, in consequence of the difference in the form of the accounts, and of the circumstance of one company adopting the principle of having a reserve fund for renewals, and other companies having no such fund.

Probable Cost of Locomotion on Great Western if made with Narrow Gauge.—We are, therefore, of opinion that the most satisfactory comparison that can be made of the economy of working the two guages, will be, by applying to first principles, endeavouring merely to determine what the working expenses of the Great Western line, with their present amount of traffic, would have been, provided it had been made a narrow gauge line, and worked with such engines as those employed on the South Western and some other narrow gauge lines.

The average weight of a passenger-train on the Great Western Railway (independent of the engine and tender, which weigh 22 tons) appears, by the returns sent to us, to be 67 tons; and the average number of passengers per train for the half-year ending the 30th of June, 1845, as appears by our comparative table, page 27, is only 47·2, whose weight, including their luggage, may be estimated at about 5 tons.

Mr. Gooch estimates each carriage and its passengers on the broad gauge, to weigh about 9½ tons, and therefore there would be seven carriages to make up the 67 tons above specified. The most commodious carriage on the narrow gauge lines, such as those on the South Western, weigh less than 5 tons; seven such carriages would therefore weigh about 34 tons, and being capable of containing 126 first-class passengers, weighing, with their luggage, 12½ tons, the total load would be only 46½ tons. Now we find, that even with a traffic as large as that on the London and Birmingham Railway, the average per train would only be 84·9 passengers, weighing about 8 tons; so that, under the supposition of a traffic of this extent, the load of the seven narrow gauge carriages so occupied would only be 42 tons.

But Mr. Gooch estimates, from his own experiments, the relative powers of traction of the broad gauge engines, and of the narrow gauge engines of the South Western Railway, when working at the same speed, as 2,067 to 1,398, or as 67 per cent., the load of the broad gauge in tons, to 45 tons which would be the corresponding load for the narrow guage, so that the narrow gauge engine has more power over the 42 tons it would have to draw than the broad gauge has over its average load of 67 tons, both exclusive of the weight of the engine and tender, the narrow gauge carriage in this supposition being supposed to contain 84·9 passengers, and the broad gauge only 47·2.

If, however, it were necessary, 224 first-class passengers might be placed in the seven broad gauge carriages, and, as it has before been said, 126 in the seven narrow gauge carriages; but it appears likely that this extent of accommodation would only be called for on such rare occasions, that the question of providing for it, except by assistant power, cannot be taken into consideration in the present comparison.

It is obvious, from the foregoing statement, that the narrow gauge engine of the class we have been considering has more power over the seven narrow gauge carriages, and a load of 126 passengers, than the broad gauge engine has over the seven broad gauge carriages, and the load of the same number of passengers; and that, therefore, if the Great Western had been a narrow instead of a broad gauge line, the South Western engines would have had the same command over the existing passenger traffic of the Great Western as its own engines now have with the present construction of that railway.

We must remark, however, that this calculation is for trains consisting exclusively of passengers and their personal luggage. In the Great Western average trains of 67 tons there is an allowance of about 16 tons for passengers and luggage, including gentlemen's carriages. Allowing the same weight of luggage on the narrow gauge line, the train would still not exceed 50 tons, which is considerably within the power of the narrow gauge engine. For it appears, by the experiments that have been recently made on the Great Western Railway, the details of which are given in the appendix to the evidence, that the Great Western engine is capable of propelling 18 tons at a greater speed than the average speed of that line; and, consequently, by the proportion above stated, the narrow gauge engine would be capable of propelling 55 tons at the same rate. We conclude, therefore, that the work would be performed at about the same expense for locomotive power.

That there may be cases in which not only the full power of a broad gauge engine is required, but even the assistance of a second engine is quite certain, but such trains form the exception, and not the rule, in railway passenger traffic, and we doubt the soundness of a principle which involves a great expense in construction, for the sake of possessing capabilities so seldom called into action.*

It is proper to observe, that the foregoing comparison would have appeared to stand more in favour of the narrow gauge, had we taken for the engine of comparison, one of those engines, of whose increased capabilities some of the supporters of the narrow gauge system have informed us; but we have preferred the comparison afforded with the South Western engine, from its being the one on which Mr. Gooch of the Great Western Railway, superintended the recorded experiments—hence our deductions are made from data furnished by the advocates of the broad gauge system, without drawing anything from the evidence on the other side; and as these deductions sufficiently demonstrate that there is no economy in the locomotive expenses for passenger-trains resulting from working a line on the broad gauge system, even on such lines as those which have at the present moment the most abundant passenger traffic, any analyzation of the evidence offered in support of the narrow gauge system appears to us to be quite superfluous.

Gross and Net Loads.—There is one point, however, stated in Mr. Gooch's comparative table, and repeated in his evidence, which appears so much at variance with the results we have obtained from other data, as to require explanation.

Mr. Gooch has asserted that the Great Western Company work their passenger-trains at half the expense per ton, at which the London and Birmingham Company work their passenger-trains. The fact is, however, that Mr. Gooch's calculations refer to the gross and not to the net loads; and therefore, the comparison is not applicable, so far as regards the profits of these companies, and affords no proof of economy in working the passenger traffic on the Great Western system.

There can be no doubt, judging both from Mr. Brunel's evidence given to us, and from his report to the directors of the Great Western Railway Company, that he originally expected there would be on the Great Western Railway a demand for carrying great numbers of passengers at high velocities, but from his own evidence it appears that the only heavy passenger traffic upon that railway is between London and Reading, and between Bath and Bristol, being a total distance of about 50 miles, out of 245.

On the remaining part of the line the passenger traffic, per train, is small.

Division of Traffic.—If the convenience of the public would admit of the whole of the passenger traffic of this portion of the line being conveyed daily by two or three large trains, Mr. Brunel's views would have been perfectly correct in providing such powerful means; but experience has proved that the public require passenger-trains to be run many times during the day, and with this frequency of trains, such numbers of passengers as Mr. Brunel has provided for cannot be expected even on railways of the largest traffic, so that practically there is a waste both of power and of means. In the case of "goods' traffic," the circumstances are not the same, railway conveyance for merchandise seems only to be required a few times in each day, and the trains are generally large. The "through" wagons have, for the most part, a full load, and the disproportion between the gross and the net weight is consequently much less than in the passenger trains; still, however, it appears from the evidence of Mr. Horne, and of other persons connected with the carrying trade, that on the London and Birmingham Railway it frequently happens that wagons are forwarded to a considerable distance, to "road-side stations," containing not more than a ton of goods: and there can be no doubt that this must happen on any long line of railway. The same also occurs in wagons coming in from branches along the trunk line, and in all such cases the heavy large wagon of the broad gauge must be disadvantageous; but although the evil is not so great with goods' wagons of the broad gauge as with their passenger carriages, still the loss by dead weight is greater with these than with smaller wagons, and we do not perceive any advantages in the broad gauge to counterbalance it; for where speed is not an object, and this is the case with goods' trains, we believe from the evidence we have received, that engines of nearly the same tractive power are to be found on many narrow gauge lines as those in use on the broad gauge.

* It appears that during the half-year ending June 30, 1845, the number of miles run by coupled and assisting engines for passenger-trains on the Great Western Railway, amounted to 11,628, and for goods trains to 51,155. The total number of miles run by the former trains being 761,493, and of the latter, 159,324.

New Railways.—Thus far we have considered the question with reference to the railways as they now exist, and composed, in a great measure, of trunk lines of considerable traffic, but the railways to be made in future will, in some degree, be branches or lines in districts having traffic of less magnitude than is to be provided for in the existing railways; and hence, if for the greater trunk lines a superiority were due to the broad gauge system, that superiority would be less for lines yet to be constructed of a smaller amount of traffic; and, necessarily, if the preference were given to the narrow gauge for the existing lines, that system would be still more entitled to the preference for the railways of smaller traffic to which we look forward.

Experiments on Broad and Narrow Gauge.—We must here add that towards the close of our inquiry, Mr. Brunel requested, on the part of the broad gauge companies, to institute a set of experiments to test the power of their engines, and Mr. Bidder, on the part of the narrow gauge companies, undertook, in consequence of such application, to make corresponding experiments on the narrow gauge. After sanctioning these trials, and being present at the performance of them, a record of which will be found in the appendix, we may observe, without entering into a minute detail of the results, or the discrepancies between the returns as furnished by the two parties themselves, that we consider them as confirming the statements and results given by Mr. Gooch, in his evidence, proving as they do, that the broad gauge engines possess greater capabilities for speed with equal loads, and, generally speaking, of propelling greater loads with equal speed; and, moreover, that the working with such engines is economical where very high speeds are required, or where the loads to be conveyed are such as to require the full power of the engine. They confirm, also, the evidence given by Mr. Bidder as to the possibility of obtaining high evaporative power with long engines for the narrow gauge; but under somewhat peculiar circumstances. It appears, moreover, that the evaporation thus obtained does not produce a corresponding useful effect in the tractive power of the engine; a circumstance that would probably be differently explained by Mr. Gooch and by Mr. Bidder; but as we do not refer to the power of this description of engine in the deductions we have made, it is unnecessary for us to allude further to them.

Conclusions.—After a full consideration of all the circumstances that have come before us, and of the deductions we have made from the evidence, we are led to conclude—

1. *That as regards the safety, accommodation, and convenience of the passengers, no decided preference is due to either gauge, but that on the broad gauge the motion is generally more easy at high velocities.*

2. *That in respect of speed, we consider the advantages are with the broad gauge, but we think the public safety would be endangered in employing the greater capabilities of the broad gauge much beyond their present use, except on roads more consolidated and more substantially and perfectly formed, than those of the existing lines.*

3. *That in the commercial case of the transport of goods, we believe the narrow gauge to possess the greater convenience and to be the more suited to the general traffic of the country.*

4. *That the broad gauge involves the greater outlay, and that we have not been able to discover either in the maintenance of way, in the cost of locomotive power, or in the other annual expenses, any adequate reduction to compensate for the additional first cost.*

Therefore, esteeming the importance of the highest speed on express trains for the accommodation of a comparatively small number of persons, however desirable that may be to them, as of far less moment than affording convenience to the general commercial traffic of the country, we are inclined to consider the narrow gauge as that which should be preferred for general convenience; and, therefore, if it were imperative to produce uniformity, we should recommend that uniformity to be produced by an alteration of the broad to the narrow gauge, more especially when we take into consideration that the extent of the former at present in work is only 274 miles, while that of the latter is not less than 1,901 miles, and that the alteration of the former to the latter, even if of equal length, would be the less costly as well as the less difficult operation.

Intermediate Gauges.—We are desirous, however, of guarding ourselves from being supposed to express an opinion, that the dimensions of four feet eight and a half inches is in all respects the mosts suited for the general objects of the country. Some of the engineers who have been examined by us have given it as their opinion, that five feet would be the best dimension for a railway gauge; others have suggested 5 ft. 3 in., 5 ft. 6 in., and even 6 ft., but none have recommended so great a breadth as 7 ft., except those who are more particularly interested in the broad gauge lines. Again some engineers of eminence contend that a gauge of 4 ft. 8½ in. gives ample space for the machinery of the engine and all the railway requirements, and would recommend no change to be made in the gauge.

We may observe, in reference to this part of the question, that the Eastern Counties Railway was originally constructed on a gauge of 5 feet, and has since been converted into a gauge of 4 feet 8½ inches, to avoid a break of gauge; and we have been informed that some lines in Scotland, originally on the gauge of 5 ft. 3 in., are about to be altered to 4 ft. 8½ in. for the same reason.

Gauge of Foreign Railways.—Whatever might be the preferable course were the questions now to be discussed of the gauge for an entire system of railways, where none previously existed to clash with the decision, yet, under the present state of things, we see no sufficient reason to suggest or recommend the adoption of any gauge intermediate between the narrow gauge of 4 ft. 8½ in., and the broad gauge of 7 ft., and we are peculiarly struck by the circumstance, that almost all the continental railways have been formed upon the 4 ft. 8½ in., gauge, the greater number having been undertaken, after a long experience of both the broad and narrow gauge in this country; nor must the fact be lost sight of, that some of these railways have been constructed as well as planned by English engineers, and amongst that number we find Mr. Brunel, the original projecter of the broad gauge. Mr. Brunel was also the engineer of the Merthyr Tydvil and Cardiff Line, which is on the 4 ft. 8½ in. gauge; and we think that the motives which led to his adoption of the narrow gauge in that instance would equally apply to many English lines.

We are sensible of the importance, in ordinary circumstances, of leaving commercial enterprise as well as the genius of scientific men unfettered; we therefore feel that the restriction of the gauge is a measure that should not be lightly entertained; and we are willing to admit, were it not for the great evil that must inevitably be experienced when lines of unequal gauges come into contact, that varying gradients, curves, and traffic might justify some difference in the breadth of gauge. This appears to be the view which Mr. Brunel originally took of the subject; for the Great Western proper is a line of unusual good gradients, on which a larger passenger traffic was anticipated, and as it touched but slightly on any mineral district, it embraced all the conveniences and advantages of the broad gauge system, and was comparatively free from the influence of those defects on which we have commented; but such a breadth of gauge, however suitable and applicable it may have originally been considered to its particular district, appears wholly inapplicable, or at least very ill suited to the requirements of many of our Northern and Midland lines.

In references to the branches already in connexion with the Great Western Railway, we may observe. that the greatest average train on the Oxford branch, for two weeks in July and October, was only 48 tons; on the Cheltenham branch, it did not exceed 46; between Bristol and Exeter, 53; and between Swindon and Bristol, it was under 60 tons. With such a limited traffic the power of the broad gauge engine seems beyond the requirements of these districts.

Expense of Altering Broad to Narrow Gauge.—We find from an estimate furnished to us, and the general grounds of which we see no reason to dispute, and the expense of altering the existing broad gauge to narrow gauge lines, including the alteration or substitution of locomotives, and carrying stocks, would not much exceed 1,000,000*l.*; yet we neither feel that we can recommend the Legislature to sanction such an expense from the public monies, nor do we think that the companies to which the broad gauge railways belong can be called upon to incur such an expense themselves (having made all their works with the authority of Parliament), nor even the more limited expense of laying down intermediate rails for narrow gauge traffic. Still less can we propose, for any advantage that has been suggested, the alteration of the whole of the railways of Great Britain with their carrying stocks and engines, to some intermediate gauge. The outlay in this case would be very much more considerable than the sum above mentioned; and the evil, inconvenience, and danger to the traveller, and the interruption to the whole traffic of the country for a considerable period, and almost at one and the same time, would be such that this change cannot be seriously entertained.

Guided by the foregoing considerations, we most dutifully submit to your Majesty the following recommendations:—

1. *That the gauge of 4 ft. 8½ in. be declared by the Legislature to be the gauge to be used in all public railways now under construction, or hereafter to be constructed, in Great Britain.*

2. *That unless by the consent of the Legislature, it should not be permitted to the directors of any railway company to alter the gauge of such railway.*

3. *That in order to complete the general chain of narrow gauge communication from the north of England to the southern coast, any suitable measure should be promoted to form a narrow gauge link from Oxford to Reading, and thence to Basingstoke, or by any shorter route connecting the proposed Rugby and Oxford line with the South Western Railway.*

4. *That as any junction to be formed with a broad gauge line would involve a break of gauge, provided our first recommendation be adopted, great commercial convenience would be obtained by reducing the gauge of the present broad gauge lines to the narrow gauge of 4 feet 8½ inches, and we, therefore, think it desirable that some equitable means should be found of producing such entire uniformity of gauge, or of adopting such other course as would admit of the narrow gauge carriages passing, without interruption or danger, along the broad gauge lines.*

(Signed) J. M. Frederic Smith, (L.S.)
Lieut.-Col. Royal Engineers.
G. B. Airy, Astronomer Royal. (L.S.)
Peter Barlow. (L.S.)

Broad and Narrow Gauges C

Return of Railways furnished by the Board of Trade, 1845.

RAILWAYS	Narrow Gauge, 4 ft. 8½ in. miles.	Broad Gauge, 7 feet. miles.	Irish Gauge, 5 ft. 3 in. miles.
Completed	1901	274	69
Sanctioned in 1844	602½	63	122½
Passed the House of Commons, Sessions 1845 and seem likely to be sanctioned in Session 1846	1628	440	772
Total length ..	4,131½	777	963½

The Broad Gauge includes the Great Western, Cheltenham branch, Oxford branch, Bristol and Exeter, and the Bristol and Gloucester completed. The South Devon now progressing, and the Bristol and Exeter branches, Cornwall, Exeter, Crediton, South Wales, Wilts and Somerset, now in parliament.

The Narrow Gauge includes 32 miles of the Arbroath and Forfar and Dundee and Arbroath Railway, 6 ft. 2 in. gauge to be altered to 4 ft. 8½ in., and the Irish gauge is confined to railways in Ireland.

Table exhibiting the Expenditure of the Great Western and London and Birmingham Railways for Locomotive Engines, Carriages, and Wagons, from the commencement of the traffic to the present time; also the Revenue Returns of each for the last two years, and the Expense of Locomotive Power, as deduced from the Half-yearly Reports of each Company.

	£	s.	d.
Great Western.—Total cost of locomotive engines, tenders, carriages, and wagons, to 30th of June, 1845	622,078	12	0
London and Birmingham.—Total cost of locomotive engines, tenders, carriages, and wagons, to 30th June, 1845	494,408	5	
These sums are exclusive of the charges for locomotive, carriage, and wagon repairs, included in the half-yearly accounts. These latter have amounted in the last two years to—			
Great Western.—From 1st July, 1843, to 30th June, 1845 ..	56,962	17	
London and Birmingham.—From 1st July, 1843, to 30th June, 1845	57,578	3	
The cost of locomotive power, including repairs of locomotive engines, coal, coke, wages, and all incidental charges, have amounted in the same period to—			
Great Western.—From 1st of July, 1843, to 30th of June, 1845 ..	156,962	2	
London and Birmingham.—From 1st of July, 1843, to 30th of June, 1845	146,172	8	
The revenue for the same two years, for the carriage of passengers, mails, goods, &c.—			
Great Western.—From 1st of July, 1843, to 30th of June, 1845 ..	1,617,995	8	
London and Birmingham.—From 1st of July, 1843, to 30th June, 1845	1,785,795	14	2
The total mileage of every passenger for the last two years amounts to—			
Great Western.—Total mileage from 1st of July, 1843, to 30th of June, 1845	128,524,232		
London and Birmingham.—Total mileage from 1st of July 1843, to 30th of June, 1845	121,529,896		

	Great Western and London and Birmingham.
Ratio of cost of engine and carriage plant	1 to ·763
Ratio of repairs of engine for 2 years	1 to 1·021
Ratio of cost of locomotive power for 2 years	1 to ·049
Ratio of passengers' mileage for 2 years	1 to ·945
Ratio of total passengers' revenues for 2 years	1 to ·1072

During the periods which these returns embrace, the lengths of line worked by the Great Western have varied by the opening of different lines and branches; but from the 30th of December, 1844, to June 30th. 1845, the number of miles worked have been constant, viz., 222 miles. The length worked by the London and Birmingham has also been constant during the same period, and Mr. Creed in his evidence states (excluding the branches) that the distances worked was 113 miles, and the revenue and mileage on this length, that is still excluding the branches, he gives as below.

Similar statements are given in the appendix of the revenue, mileage, &c., on the Great Western for a like period; from which we have the following comparisons:—

	Miles.
Great Western, length of line worked	222
London and Birmingham, length of line worked	113
Great Western, total passengers' mileage	35,967,713
London and Birmingham, total passengers' mileage	38,758,260
Great Western, miles run by passenger trains	761,483
London and Birmingham, miles run by passenger trains	456,826
Great Western, average number of passengers per trains	47·2
London and Birmingham, average number of passengers per trains ..	84·9
Great Western, average passengers' revenue per trains per mile ..	9s.
London and Birmingham, average passengers' revenue per trains per mile ..	14s. 9d.

Improvement of the Severn.—The River Severn, which is subject to alternate floods and droughts, has, during the last two years, been greatly improved by dredging, and by the erection of gigantic weirs and locks. These works are now completed from Bewdley to Worcester, a distance of seventeen miles, and from Worcester to Gloucester the river is being deepened by dredging and closer enbankment, the Severn Act limiting the erection of weirs within the county of Worcester. By the operation of dredging, long rocky shoals have been entirely removed. The hardest rocks are first blasted under water, and, therefore, easily removed by the dredging machines. Upwards of 200,000 tons of marl, rock, gravel, and soil have already been raised from the bed of the Severn by Messrs. Grissell and Peto's dredging machine alone, besides what has been removed by another contractor. At Gloucester it has been necessary to remove the entire foundation of one of the piers of the old bridge, and in the course of this operation some curious relics of ancient coins have been discovered.

Sheerness.—The whole of the guns for the old fortifications have now arrived from Woolwich. They are 63 in number, and are of the following description:—4 eight-inch guns, 98 cwt. each, 11 feet long; 29 eight-inch guns, 65 cwt. each, 9 feet long; 26 6½-inch guns, 56 cwt. each, 9 ft. 6 in. long; and 4 6½ inch guns, 82 cwt. each, 6 ft. 6 in. long. The workmen now await the arrival of the carriages and platforms from Woolwich; the masonry on which they are to rest is all ready to be laid down. The guns are to be placed as follows:—20 on the Halfmoon Battery at the Point, 13 on the Admiral's platform overlooking the said battery, and the remaining 30 along the works protecting the barracks. The new works progress rapidly; the battery forming opposite the dockyard gate is now carried to the height of the platform; its further progress has, however, been deferred till the formation of the deep ditch by which it is to be protected, and on which all the workmen are now concentrated. Wooden profiles are now up for another battery, with which this is to be connected by a musketry wall, while to the eastward it will be continued into the bastions extending from the Thames to the Medway.

NEW CHURCHES.

All Saints, Rise, Yorkshire.—Consists of a nave and chancel in the First Pointed style, and cost about 4000*l*; it is capable of containing 200 persons. The chancel is ascended by one step at the nave and two more at the altar. The stalls and the fittings throughout are of oak; the floor is laid with encaustic tiles; the wall as high as the string-course is inlaid with tiles. A recess in the wall is used for a credence. The east window of three lancets, is filled with stained glass by Wailes. The stonework between has received decorative colouring, and the walls are ornamented with scrolls. The spaces between the beams of the roof are painted blue with gilt stars. The capitals of the pillars are gilt.

Homerton.—A new church is building in Homerton from the design of Mr. Ashpitel. When we have praised its material, Kentish rag with the dressings, &c., in Caen stone, and its general plan, chancel, nave, south-aisle, porch, and west tower, we have said all that we can in its favour. The chancel is very short, and a sacristy is added to the north-west, instead of the north-east of the chancel. Again the style chosen is Third Pointed, but with a poor attempt at tracery of the Middle pointed period. The mouldings throughout are very inaccurate. The west tower is square, with a corner turret; all on too small a scale. The aisle is to have a separate gable, with great haunches.

St. John, East Chislehurst, Kent.—The ground plan of this church is a wide oblong, without any pretence to a chancel. There are north, south, and west galleries, the latter containing the organ. At the east end of the south cloister there is a door labelled "*Chapel Clerk's Office.*" Corresponding with this on the north side, is another door, with the inscription "*Minister's Vestry*" upon it. The altar, an old oaken table well carved; altar chairs the same; an altar-piece of Carrara marble; altar-rails of massive grey marble; a pulpit of oak paneled with bas relief, a hexagonal font of white marble; a brass lectern; a litany desk (turned the wrong way), these form a catalogue of gems seldom met with in this country. Indeed the whole have been imported from the continent. There are two thin western towers capped with short shingled spires. One of them contains six bells. The style of the church is intended to be Italian. The windows are all roundheaded triplets glazed with ground glass; that at the east end is included in an enormous arch of construction. The masonry is of flint, with dressings of red and white brick, and white ashlar. The roof is of stained deal. The church is said to have cost nearly 8000*l*, and holds 500 worshippers. The architect is a Mr. Wollaston. Here one has again to lament the lavish expenditure of money upon an unworthy design.

West Meon, Hampshire.—Consists of a chancel, (30feet,) nave, (70,) with aisles, south porch, and west tower. The style is the transition between First and Middle Pointed, and yet there is not to be a spire. The material is flint dressed with stone. The reredos is a trefoiled arcade. There are sedilia, only however two in number, and a credence. The roof and seats are of deal. The flooring of the chancel is blue and white lias. Messrs. Scott and Moffatt are the architects, and the building partakes too much of the fineness conspicuous in their designs. In particular we object to the pert-looking unmeaning window over the north door.

Loughton.—We have seen a lithographed view of "the new church, Loughton," taken from the N.E., to which Mr. S. Smirke's name is attached as architect. It is a most unsatisfactory production: of English Romanesque style, cruciform, with low square central tower, having no capping whatever above its parapet. The windows are all large and round-headed: the side walls high: the strings clumsy: the buttresses very unlike Norman: and the whole effect quite different from that of any ancient church we ever saw. The view shows a north-west porch, a door in the north transept, and a third door into a kind of belfry turret, which occupies the angle between the north transept and chancel. The faces of the two gable-fronts shown in the view are recessed, not under corbel tables, but under a flatsided triangular head following the lines of the low gable, in the most remarkable way. We thought it had been long ago admitted that all Romanesque towers ought to have a high capping; nothing can be imagined worse than the flat parapet in this example.

Brockham, Betchworth, Surrey.—Consists of chancel, (not long enough, but very much better than the ordinary run,) nave, transepts, an eastern aisle to each transept, north porch, and central tower. We have often protested against the adoption (except under peculiar circumstances,) of the cruciform arrangement. In this case it was especially bad, because the funds, we understand, fell short. The style is First Pointed. The lancets are not too broad, but too short, and far too high up: the east end contains a triplet of a very nondescript kind. The north porch is immensely too large, and absurdly elaborate. The string-course is grievously faulty. And, worse than all, the piers, both of these aisles and the belfry arches, are made indeed of local stone, but are to be cased, and all the mouldings, run, in plaister. On the whole, this church is very unworthy of Mr. Ferrey.

Tubney, Berkshire.—A small church, the shell of which did not cost more than 600*l*. or 700*l*, has been built here from the designs of Mr. Pugin, at the expense of St. Mary Magdalen College, Oxford. The most striking feature is the roof, of unusually sharp and lofty pitch: which has been censured as excessive by many who are most disposed to favour high roofs. The well-known example of the roof of All Saints, Skelton, may be pleaded as a precedent. The west end displays a bell gable of two arches, and a quatrefoil pierced between the heads, with a floriated cross above. All the windows on the north are of one narrow light with trefoil heads; the east window of the chancel has three lights with flowing tracery, and those on the south side are of two lights in form and proportion like those on the north. The plan consists of chancel, vestry in the north side, nave, and south porch, the whole paved with small tiles of a dark red colour. The altar and pulpit are of stone, both plain, as is almost every detail of the church, with the exception of the font, which is very richly and beautifully carved.

St. James, Woodside.—We have seen a wood-engraving of this church from the north-west. The architect is Mr. C. W. Burleigh, of Leeds. The style is Middle Pointed; and the plan consists of a chancel, nave with west bell-cote and west door, north aisle, with a separate gable, and north porch. All the gables are coped in stone, and have crosses. Upon the whole we are well satisfied, and hope to meet Mr. Burleigh again.

Sandown Brading, Isle of Wight.—We have seen a lithograph of the new church about to be erected at Sandown Brading, Isle of Wight, in the First Pointed style. There is a south aisle under a separate gable. The east window of the aisle is a triplet, and too much like a chancel east window. The tower with broach spire is engaged in the aisle at its west end. The roofs are of a good pitch. Mr. Woodman is the architect of Sandown church.

CHURCH RESTORATIONS.

St. Mary, Battel.—Some very interesting wall-paintings, were lately discovered in the semi-Romanesque nave of the decanal church of St. Mary, Battel. In spite of earnest remonstrances the churchwardens have again whitewashed them. The splays of the clerestory windows were filled with whole length figures. The works in the chancel and its aisles will be done in the right direction, these being free from churchwarden's influence.

St. Mary, Snettisham.—The magnificent Middle Pointed west window of this church has been opened and repaired by the exertions of the curate. It is to be filled with stained glass by Mr. Warrington.

St. Michael, Sowton, Devonshire.—The church of St. Michael, Sowton, Devonshire, has been recently rebuilt, at the sole charge of J. Garrett, Esq. Mr. Hayward is the architect. The style is Third Pointed. The plan consists of chancel, nave, north aisles, and western tower. The stone is red-sandstone ashlared; the dressings are of Caen stone. The exterior effect is described as being religious and unobtrusive. There is no saving of expense externally, and there is much enrichment within. The windows are filled with stained glass chiefly by Willement.

St. Leonard, Beeford, Yorkshire.—This church consisted of a chancel, nave, and south aisle, and presented all the disfigurements of sash windows, pagan Tate-and-Brady galleries, with a low ceiling entirely hiding the wood-work. The restoration has been undertaken and carried out in an excellent spirit. A new north aisle has been added, containing four windows. In the nave the ceiling has been removed, and the old roof has been enriched with cusps, &c. The gallery which occupied the western end, and completely blocked up the tower, and a very beautiful arch, has been pulled down, and opens to view a fine Third Pointed window. A large stack of pulpit and reading desk is shortly to be replaced by new ones of proper proportions.

St. Mary, Romsey.—The magnificent abbey church of St. Mary, Romsey, is under restoration by Mr. Ferrey. The spirit with which the work has been undertaken is deserving of all praise. We are grieved however to see such little respect paid to the peculiar character of the Romanesque masonry. The new work is fine-dressed and close-jointed. Such an alteration goes far towards destroying the genuineness of any building. The offensive gallery which spanned the church has been already swept away, and the lantern is about to be opened.

St. Mary, Eastwell, Kent.—The church which is mainly Middle Pointed, is of that peculiarly unmanageable form, a chancel and nave, with a single aisle (a south one) wider than the nave itself, and with a separate roof. The nave has a chancel arch, not the aisle. A rood-screen has been put up, and the east end of the aisle parclosed off. The parclose has no opening at all, leaving the chantry to be entered perforce through the chancel. The wood-work is very costly and well-intentioned, wanting however in simplicity and in force. The prayer-desk we are sorry to say looks west. There are altar chairs, arranged however north and south. We may in passing, remark the extreme shortness of the chancel. The nave and aisle are filled with open seats of oak, with poppy-heads.

St. Botolph, Boston.—The restoration of the magnificent church of St. Botolph, Boston, under the superintendence of Messrs. Scott and Moffatt, has commenced. The interior of the nave has already been denuded of whitewash, and some architectural restorations have been made in the exterior.

St. Denis, Rotherfield, Kent.—The shingle roofing of the spire (surmounted by a noble cross and a cock), and the interior of the chancel have been repaired: the piscina, sedilia, and the stoup at the Priest's door, all in the south wall, have been restored. The piscina is circular-headed; the sedilia are First Pointed, and composed of two arches of unequal span, separated by a single shaft, and apparently intended for one and two occupants respectively. The pavement of the entire sacrarium has been raised.

St. Julian, Wellow.—The oak open benches in the nave have been carefully restored, and the fine rood-screen cleaned. The chancel has been rebuilt and its roof leaded. Its fittings are unfortunately of deal. A west gallery is permitted to remain. The font is removed to its proper place and a north door is opened.

St. Nicolas, Cranley, Surrey.—The chancel is seated stallwise, but without returns: the details are poor. The paving is of encaustic tiles. The sedilla have been restored, but are not used, nor can they be while the altar rails remain. There is a poor eagle, a pulpit wanting height, (a fault on the right side), and a reading-pew that faces south. In the nave are two horrible but elaborately panelled galleries between the first and second pews.

St. Margaret, Lynn.—The parclose of the chancel of St. Margaret, Lynn, is in course of restoration by Mr. Patterson, carver, of that town; under the superintendence of the Lynn and West Norfolk Architectural Society.

Jesus College, Cambridge.—We are delighted to be informed by a correspondent, that the master of Jesus College, Cambridge, has announced his intention of presenting five stained glass windows for the lancets on the north side of the choir of the college chapel. The "Five Sisters." of York, will be the model.

THE COLLECTION OF SEWAGE MANURE.

In connection with the efforts that have recently been made to improve the sanatory condition of large towns, one of the most important propositions is the plan entertained, *applying to agricul ure the refuse and drainage of London.*

It is argued, and apparently with good reason, that by this plan not only would large quantities of valuable manure, which is now wasted, be usefully applied, but that also, the plan would involve more effectual means of removing it, than by the flow of the Thames, and that a fruitful cause of miasma would be removed.

Two modes of effecting the requisite object have been suggested. In the First Report of the Health of Towns Commission are published various reports and estimates made by Mr. Smith, of Deanston, in which he suggests the practicability of dispersing sewage water of lands in the vicinity of London by a system of fixed jets or hose pipes, and more recently details are given in a prospectus issued by the Metropolitan Sewage Company, to which Mr. Smith's name appears as consulting engineer. The scheme is stated by the prospectus to have been *matured* for conveying the sewage water of London, by means of a system of *pumping-engines* and *pipes analogous* to that of the *great Water Companies*, and thus distributing the fertilising fluid all over the land, in such manner and proportions as may be best adapted to the various kinds of field and garden cultivation. The average quantity required for agriculture is estimated at 80 *tons per acre*, which can be supplied within about 20 *miles round the metropolis* at less than a quarter of the cost of stable or farm-yard manure, and at *one-tenth of the expense.*

The contents of these sewers are to be raised by powerful steam-engines and distributed by pipes over an extent of *sixty square miles*, through the gardening and agricultural districts to the *westward.* A sum of 300,000*l.* only will be required to carry this part of the plan into effect. On comparing the relative expense of conveying solid and liquid manure, it is calculated that the cost of the conveyance of liquid manure by pipes, is, at the very outside, *one-twentieth* of the transport of solid manure *by carts.*

The authority quoted is Mr. T. Hawksley, Engineer, of Nottingham; he states in evidence that the cost of transmitting water to a distance of *five miles*, and to a height of 200 feet, including wear and tear of pumping machinery, fuel, labour, interest of capital invested in pipes, reservoirs, engines, &c., amounts to 2½d. per ton; the cost of *cartage* to the same distance and height will, under favourable circumstances, amount to 4s. per ton.

This plan depends chiefly upon the authority of Mr. Smith's report and estimates, published by the Health of Towns Commission.

He appears to have made several experiments respecting the diffusion of water by jets; in applying the results of his experiments to the case of sewage manure. He states that the water must be at a pressure of from 100 to 150 *feet at the point where it is to be distributed by hose* over the land. With a pressure at the hose of 120 feet, he found that he could, through a 2¼ inch hose and a one inch nozzle, distribute water over an area of *two* statute acres—but to be safe, say one statute acre, and if the land rises an addition must be made to the pressure equal to the rise in the land. Mr. Smith states that for his estimate he assumes 200 feet total height to raise the water.

Great doubts have however been expressed as to the practicability of distributing the sewage water by jets. In a report to the London Sewage Company Mr. Wicksteed, C.E., proposed an altogether different plan, and brought forward powerful arguments for condemning *in toto* Mr. Smith's scheme. The following extracts embody the principal points of his reply:—

"The quantity of sewer water to be supplied is equal to 17,920 gallons per acre per annum, one-third of which Mr. Smith says can be delivered in one hour, or 99.55 gallons, or about 16 cubic feet, per minute. At this rate the engine would supply 5 jets only at a time. Mr. Smith provides for 64 jets, and 8 lines of services each two miles long, which gives 8 plugs to each line of service pipes. Mr. Smith says he never intends more than two jets to be playing at one time on a service. But if, instead of the jets playing for an hour over an acre, they are playing for rather more than three hours; then two jets on each service, or 16 jets, may be playing together, and the engine will supply them.....The additional head required to overcome the friction of the water passing through the main, services, and hose, will be equal to 24 feet; but if only 8 jets, or half the number in the former estimate, are playing at the same time, then the water must travel through the hose at twice the velocity, (to deliver an equal quantity of water) and the head of water to overcome the friction must be 35 feet, and if only 5 jets are open at the same time, as proposed by Mr. Smith, to deliver the same quantity of water in the same time, the additional head required to overcome friction would be still further increased to 67 feet. Mr. Smith however seems to have lost sight of the fact that friction of water through pipes increases as the squares of the velocity, and that to force double the quantity of water through the same sized pipe, is equivalent to doubling its velocity, and would therefore require four times the pressure, and consequently an addition must be made to the proposed head (viz. 200 feet) of 24 feet, 35 feet, or 67 feet, depending upon the number of jets opened at one time, which regulates the delivery; and if in the latter case the level of the ground proposed to be manured should be 133 feet above the town,* there would be *no pressure* at the nozzle to create a jet at all, unless the head or pressure be increased beyond the 200 feet, and which head, to produce the effect Mr. Smith proposes, must be 224 feet, or 235 feet, or 267 feet, depending upon the number of jets playing at *one* time. But taking the most favourable arrangement for working the jets, which will be when the greatest number are playing at one time, the proposed head must be increased to 224 feet, and the power to 33 6-10 horses, and this will be putting the scheme in a much more practicable form, and will enable me to check the estimates.

Mr. Smith however further asserts that the twelve inch pipe is ample for *double* the extent of country, and therefore considers he may reduce his estimate of the cost of the main to one-half.†—If the main is ample for *double* the extent of country, it must be capable of conveying *double* the quantity of water, and of supplying the additional number of services for *double* the extent, and the head required to overcome the friction will be increased; with sixteen jets playing *on each plot*, it will be equal to 92 feet instead of 24 feet; with eight jets *on each plot*, it will be 104 feet instead of 35, and with five jets on each plot, 135 feet instead of 67. It is evidently erroneous therefore to suppose that the same sized pipe *could* convey *double* the quantity of water "to supply other sections of land of equal extent."

Again: Mr. Smith gives another estimate of the cost of supplying *double* the quantity of sewer water to the *same* section, and assumes that this can be done for the *same* outlay, forgetting that the head for friction must be quadrupled; and that if 16 jets are to be supplied with double the quantity of water, it would require a head of 96 feet instead of 24 feet; and for 8 jets it would be 140 feet instead of 35 feet; and for 5 jets 268 feet instead of 67 feet; but taking, as before, the most favourable case, that of the 16 jets, the head of water must be 296 feet instead of 200 feet; and the power required for raising *double* the quantity of water, under this *increased* pressure, must be equal to 88.8 instead of 30 horses power.

The next point for consideration, and a most important one, in reference to the supply of sewer water by pipes, is the actual number of days during the year, on which the engines can be kept at work pumping the sewer water on to the lands—as it is evident that upon this point must depend the power of the engine, the size of the pipes, and the capacity of the reservoir for preserving the sewage, at periods when it cannot be thrown over the land. Assuming the periods for this purpose to be on the aggregate equal to six weeks in the year; and that the engine will be constantly pumping sewer water during this time, 7 days per week, for 12 hours each day, the quantity of water raised by the engines must be equal to 6,300 cubic feet per minute.

As the sewage water is constantly flowing every day throughout the year, while the period for delivering it upon the lands is but six weeks—i.e. 504 hours in 8,760, it is evident that the reservoir must be capable of holding the supply afforded during 8,256 hours, or 5,020,278 tons; consequently the capacity of the reservoir will be 6,663,917 cubic yards, and at a depth of 12 feet, or four yards, its area at the mean water line will be equal to 344 acres—if a square, the length of each side will be 1,290 yards, OR NEARLY THREE-QUARTERS OF A MILE.

Taking Mr. Smith's standard of 200 feet as the whole pressure at the engine, which, as he proposes to raise the water over a standpipe column, may be considered sufficient,‡ the power of the engines required will be equal to 2,389 horses, and should it be thought advisable to increase the pressure, the power must also be increased in the *same* ratio.

In explaining the plan proposed to be substituted, Mr. Wicksteed adduces some general reasons for supposing that the cleansing of the metropolis would be secured effectually by mechanical means, than by the tidal action of the river. At present it is necessary to make the main sewers of great capacity, because their contents can be delivered into the river, at or

* That this elevation may be expected in cases where it is necessary to go to a distance from the town, seems to have been anticipated by Mr. Smith himself, in his statement quoted in page 12 of this Report, where he states "That the water of most towns can be disposed of at from 50 to 100 feet, and will seldom be required to be raised more than 400 feet.

† "One-half of the cost of the main pipe is only charged, as, from its position and capacity, it is sufficient to supply other sections of land of equal extent."—See Mr. Smith's Report on the Application of Sewer Water to Agricultural purposes. Published by the Health of Towns Commission.

‡ The height of the standpipe lately erected by me at the Grand Junction Water Works, near Kew Bridge, is about 210 feet,—the height of the Monument is about 202 feet.

near low water only—a period at which the delivery upon the shores most offensive to the public; and although this part of the evil might in some measure be remedied by the adoption of the plans proposed by Mr. Walker and Mr. Page, for extending the existing sewers into low water, still the contamination of the river would remain the same. At all other states of the tide, the sewage is pent up and held back, these large sewers becoming reservoirs, to contain the quantity collected during those periods in which the height of the tide prevents its discharge into the river.

Another evil now arises, not more offensive than injurious: the foul air not being carried off with the current into the river, necessarily and naturally rises through any openings it can find, and a stream of noxious effluvia is evolved.

A further disadvantage resulting from this penning up of the sewage, is, that the current through the sewers being checked, the water becomes quiescent, and the heavy particles previously held in mechanical suspension are deposited, and accumulate. When the current in the sewers re-commences, it is slow, depending upon the rate at which the tide falls into the river. Until it has fallen below the level of the pent-up sewage, there is no fall in the sewer. Then as the tide falls inch by inch, so does the fall in the sewer increase, but not in the same ratio, because the water being always running, the relative difference between the two levels is always diminishing. The case would be different were the sewer water held back by mechanical means, until there was a sufficient fall of tide in the river; but it is not so—the process is gradual, and no fall is obtained sufficient to scour away the accumulated deposits. Hence the necessity of manual labour to clear away these offensive deposits, which must be brought to the surface, or for machinery for carrying it off by flushing, and the demand for larger supplies of water, which would be useless unless there was an uninterrupted current in the sewers.

The following is an outline of Mr. Wicksteed's own plan of making the sewage manure available. He proposes to collect it in one large reservoir where it is to be dried and packed like guano for sale. As regards the northern side of the Thames, it is proposed to construct a Circular Sewer of eight feet diameter: to extend from the end of Grosvenor-road, to pass through, in an easterly direction, Tothill-street, Westminster Abbey-yard, King-street, Whitehall, Strand, to the end of Fleet-street; from thence a sewer of twelve feet diameter in continuation across through Ludgate-hill, the south side of St. Paul's Church-yard, Watling-street, Cannon-street, Tower-hill, Ratcliffe highway, Commercial-road, under the river Lea, above the Iron Bridge, and from thence in a straight line through the West Ham Marshes, to the proposed works, in an angle formed by the western banks of Barking Creek and northern banks of the Thames.

The necessary communication between the present sewers and the intercepting sewer will be effected by means of shafts from the top of the proposed sewer to the underside of the existing sewers, so that whatever so flows through the present sewers must flow into the intercepting sewer; unless in case of long continued rains or storms, when if much more than double the usual quantity of water should pass down, then as soon as the intercepting sewer is fully charged, the surplus water would run off through the old channels into the Thames. The sewers will, however, at these times, be relieved by an additional outlet of large capacity, the proposed sewer forming a communication with the Thames at Barking. All the flaps at the mouths of the present sewers will have to be made water-tight, to prevent the water of the Thames flowing at high water into the intercepting sewer, *unless required*, although this, of course, will not prevent their being available for allowing the surplus waste to flow into the Thames when necessary.

The new sewer has a fall of 12 inches per mile, which will give a velocity of 120½ feet per minute in the 12 feet sewer, and 98 2-10 feet per minute in the 8 feet sewer. The main sewer will terminate in a receiving reservoir, in the Barking Marshes. The engines will be equal to an aggregate power of 1,000 horses, and will be capable of raising, when worked at their full power, 56 feet high, 18,112,320 cubic feet in 24 hours, equal to more than 2½ times the present ordinary quantity of sewer water. The sewer water will be raised into reservoirs sufficiently elevated to allow of its solid contents being deposited at a level above the Trinity high water mark, so that it can easily be shipped, or loaded into railway trucks, and that the refuse liquid may be discharged at all states of the tide. And lastly, the deposit in the reservoirs will be removed periodically, and dried by artificial means, and then compressed and packed up, ready for transmission by land or water.

TUBULAR BRIDGE OVER THE MENAI.

The following is an abstract of the report on this gigantic undertaking, made by Mr. Robert Stephenson to the Chester and Holyhead Railway Company, and read at their last meeting.

"I have throughout the experiments carefully studied the results as they developed themselves, and I am satisfied that the views I ventured to express twelve months ago were in the main correct, and that the adoption of a wrought-iron tube is the most efficient, as well as the most economical description of structure that can be devised for a railway bridge across the Menai Straits.

"In the course of the experiments, it is true, some unexpected and anomalous results presented themselves; but none of them tended, in my mind, to show that the tubular form was not the very best for obtaining a rigid roadway for a railway over a span of 450 feet, which is the absolute requirement for a bridge over the Menai Straits.

"The first series of experiments was made with plain circular tubes, the second with elliptical, and the third with rectangular. In the whole of these, this remarkable and unexpected fact was brought to light, viz., that in such tubes the power of wrought-iron to resist compression was much less than its power to resist tension, being exactly the reverse of that which holds with cast-iron; for example, in cast-iron beams for sustaining weight, the proper form is to dispose of the greater portion of the material at the bottom side of the beam, whereas, with wrought-iron, these experiments demonstrate beyond any doubt that the greater portion of the material should be distributed on the upper side of the beam. We have arrived therefore at a fact having a most important bearing upon the construction of the tube, viz., that rigidity and strength are best obtained by throwing the greatest thickness of material into the upper side.

"Another instructive lesson which the experiments have disclosed is, that the rectangular tube is by far the strongest; that the circular and elliptical should be discarded altogether.

"This result is extremely fortunate, as it greatly facilitates the mechanical arrangements for not merely the construction, but the permanent maintenance of the bridge.

"We may now, therefore, consider that two essential points have been finally determined—the form of the tube and the distribution of the material.

"The only important question now remaining to be solved is, the absolute ultimate strength of a tube of any given dimensions. This is, of course, approximately solved by the experiments already completed; but Mr. Hodgkinson very properly states, that others, with tubes of more varied dimensions, should be continued, in order to clear up some anomalies which still exist.

"The formula, as at present brought out by Mr. Hodgkinson, gives the strength of a rectangular tube of the dimensions I proposed—viz, 450 feet long, 15 feet wide, by 30 feet high (assuming the plates to be one inch thick) equal to 1,100 tons applied in the centre, including the weight of the tube itself; but, deducting the latter, equal to 747 tons in the centre, or double this, supposing the weight to be uniformly distributed over the whole 450 feet.

"This amount of strength, although sufficient to carry any weight that can in practice be placed upon the bridge, is not sufficiently in excess for practical purposes. It is on this ground, therefore, I have requested Mr. Hodgkinson to devise a few more experiments in the shape best calculated to free the formula from all ambiguity. In the meantime, however, as I consider the main question settled, I am proceeding with the designs and working plans for the whole of the masonry, which I expect to have the pleasure of submitting to you in a fortnight from this time.

"You will observe in Mr. Fairbairn's remarks, that he contemplates the feasibility of stripping the tube entirely of all the chains that may be required in the erection of the bridge; whereas, on the other hand, Mr. Hodgkinson thinks the chains will be an essential, or at all events a useful auxiliary, to give the tube the requisite strength and rigidity. This, however, will be determined by the proposed additional experiments, and does not interfere with the construction of the masonry, which is designed so as to admit of the tube with or without the chains.

"The application of chains as an auxiliary, has occupied much of my attention, and I am satisfied that the ordinary mode of applying them to suspension bridges is wholly inadmissible in the present instance; if, therefore, it be found hereafter necessary or desirable to employ them in conjunction with the tube, another mode of applying them must be devised, as it is absolutely essential to attach them in such a manner as to preclude the possibility of the smallest oscillation.

"In the accomplishment of this I see no difficulty whatever; and the designs have been arranged accordingly, in order to avoid any further delay.

"The injurious consequences attending the ordinary mode of employing chains in suspension bridges were brought under my observation in a very striking manner on the Stockton and Darlington Railway, where I was called upon to erect a new bridge for carrying the railway across the river Tees, in lieu of an ordinary suspension bridge, which had proved an entire failure.

"Immediately on opening the suspension bridge for railway traffic, the undulations into which the roadway was thrown, by the inevitable unequal distribution of the weight of the train upon it, were such as to threaten the instant downfall of the whole structure.

"These dangerous undulations were most materially aggravated by the chain itself, for this obvious reason,—that the platform or roadway which was constructed with ordinary trussing for the purpose of rendering it comparatively rigid, was suspended to the chain, which was perfectly flexible, all the parts of the latter being in equilibrium. The structure was, therefore, composed of two parts, the stability of the one being totally incompatible with that of the other; for example, the moment an unequal distribution of weight upon the roadway took place, by the passage of a train, the curve of the chain altered, one portion descending at the point immediately above the greatest weight, and consequently causing some other portion to ascend in a corresponding degree, which necessarily raised the platform with it, and augmented the undulation.

"So seriously was this defect found to operate, that immediate steps were taken to support the platform underneath by ordinary trussing; in short, by the erection of a complete wooden bridge, which took off a large portion of the strain upon the chains. If the chains had been wholly removed, the substructure would have been more effective; but as they were allowed to remain, with the view of assisting, they still partake of these changes in the form of the curve consequent upon the unequal distribution of the weight, and eventually destroyed all the connections of the wooden framework underneath the platform, and even loosened and suspended many of the piles upon which the framework rested, and to which it was attached.

"The study of these and other circumstances connected with the Stockton-bridge lead me to reject all idea of deriving aid from chains employed in the ordinary manner.

"I have therefore turned my attention to other modes of employing them in conjunction with the wrought-iron tube (as suggested by Mr. Hodgkinson), if such should be found necessary upon further investigation.

"As I have already stated in this I perceive no difficulty whatever; indeed there is no other construction which has occurred to me which presents such facilities as the rectangular tube for such a combination.

"Having, I trust, clearly explained my views in reference to this important work, I have only to add that in two months I expect every arrangement will be completed for commencing the masonry, which shall be conducted with the utmost activity and vigour.

"I can scarcely venture to say, until after these arrangements are finally completed, at what period we may calculate upon the completion of this bridge; but I cannot recommend you to calculate upon the whole being accomplished in less than two years and a half."

WEIRS ACROSS RIVERS.

Report by the Committee of the Clyde Trustees on the Weir Question.

The Committee believe the present position of the Clyde Trustees, as regards the question of the weir proposed to be erected across the Clyde, is as follows:—From the Act procured last Session of Parliament by the Bridge Trustees, containing clauses to the following effect:

1. That the Bridge Trustees are entitled to form a new dam or weir at or about one hundred and forty yards above Hutcheson's Bridge, having a lock or work therein, or connected therewith, at the expense of the Clyde Trustees.

2. When these works are erected, the Bridge Trustees are then authorised to remove the weir or works placed at the Stockwell Street Bridge by the Clyde Trustees, at the Clyde Trustees' expense

3. The Clyde Trustees are obliged to contribute a sum towards sinking and building the piers and foundations of the new Bridge at Stockwell Street. And the Clyde Trustees are obliged to maintain the weir and lock constructed by the Bridge Trustees, at their expense, in all time coming. No detailed plans or estimates exist of the weir and lock. The Act provides that the cost to the Clyde Trustees, of the whole works for which they are made liable, shall be fixed by two Engineers or Arbiters appointed by the Sheriff.

Whether the Clyde Trustees ought to contribute to the building of a Bridge over the Clyde, is not within the remit to this Committee; and having stated the present position of the Clyde Trustees as regards the weir, the Committee proceed to the consideraton of the effect of the proposed dam or weir upon the navigation of the Clyde.

The Committee believe that all Engineers now act upon the principle of giving the greatest possible freedom of admission to the tidal waters, as the best means of improving navigable rivers,—the recession of these waters carrying down with them to the sea, the alluvial matter held in suspense by the waters of the river; and in proportion to the quantity and velocity of the retiring tidal wave, is the benefit derived from its cleansing and deepening power.

In order to carry out this principle, now well understood and universally acted upon, Engineers widen, straighten and deepen the channel of rivers, from the sea upwards, as far as the tidal wave can be enticed to come, and break up and remove all obstacles to its progress, whether natural or artificial. The tidal wave in the Clyde, according to the report of the late Mr. M'Quiston, confirmed by subsequent observation, can be made to flow seven miles above the City of Glasgow, and give an additional pressure and impetus to the retiring tidal wave of not less than eighty-millions of cubic feet of water at ordinary tides; and if the river be properly deepened, even this quantity of water may be increased. The Committee therefore take leave to recommend that no weir or dam be erected across the Clyde within the reach of the tidal flow.

The Trustees are aware that the largest portion of their stated outlay is upon dredging in the River and Harbour; and the Committee are satisfied that a very large proportion of this outlay might be saved by the employment of the powerful natural agency of the tidal waters. The expense of dredging from July, 1840, to July, 1844, amounted to a very large sum, and it constitutes by much the largest item of our annual expenditure. The heaviest portion of this expenditure was upon the Harbour, where dredging is performed at great inconvenience to the shipping, and to the business of the Port. Nor will it in the opinion of the Committee, ever be otherwise, until the River above be cleaned and deepened, and a body of water procured sufficient to scour the Harbour, which at present serves as a settling pool for the upper waters.

It will be said that the Clyde Trustees have no power under their Acts to operate upon the River to the eastward of Stockwell Street Bridge, and that their Acts bind them to maintain the present level of the River.

The Committee believe that if the Clyde Trustees can show that the Navigation of the Clyde is to be benefited by an extension of their powers, say for seven miles above the Stockwell Street Bridge, penetrating into the heart of the mineral districts, Parliament will grant these powers; and in regard to their obligations to maintain the present level of the River to the east of Stockwell Bridge, for the protection of certain public works, the Committee believe that the Clyde Trustees were coerced into the admission of these clauses into their Bill, and that there are other and better modes of protecting these works than by a weir across the Clyde. The Committee refer to the analogous circumstances and condition of similar works along the course of the River, beneath the Stockwell Street Bridge, because, if a like protection to these public works had been sustained, there could have been no deepening or improvement of the Clyde Navigation. The Committee, in short, believe, that no public companies, whether constituted by Act of Parliament as Canal Companies, or Water Companies, Joint Stock Companies, or private individuals having works on the banks of a navigable river, using its waters, or having a right of access thereto, can for their interests control or prevent the improvement of a public navigable river, as far as the tidal flow reaches.

From the absence of all detailed plans or descriptions of the works to be erected at the weir, the Committee can give the Trustees no information as to the height or *elevation* of the intended weir; but from its containing or being connected with a lock, the committee are led to believe that the weir or dam must be elevated to *such a height* as to enable the lock to be wrought at all times of the tide, and in all conditions of the river, or it is evident it must be useless for navigation purposes. The Committee cannot believe that so bold and injurious a measure *as the elevation* of the channel of the Clyde would be attempted, although there is an indication of such an intention on the very small plan submitted to Parliament; and without such elevation, the works described appear to the Committee to be either useless or impracticable.

The Committtee, therefore, take leave to recommend that the Clyde Trustees apply to Parliament next Session for powers to open up the navigation of the Clyde to a distance of say seven miles above the City of Glasgow, to construct all necessary works, and levy such dues as shall be judged fitting and proper. They will thus, in the opinion of the Committee, give great facility for the conveyance of minerals, country produce, and traffic of every description to and from the Harbour; and what is of equal, if not of greater importance, they will, by the recession of the tidal waters, be enabled to keep the whole channel of the river clear at a very moderate expense, and thereby be enabled to devote several thousands a year, now expended in dredging the River and Harbour, to other purposes.

The Committee farther recommend that the Clyde Trustees intimate to the Bridge Trustees their intention of going to Parliament next Session, in order to prevent the Bridge Trustees from constructing a weir across the River Clyde, with a lock or works therein, and that the Bridge Trustees, in the erection of their Bridge, do not in the meantime interfere with the bed of the River, so as to prejudice the Clyde Trustees in their position as regards the Water Company and other parties.

Before concluding their Report, the Committee also beg to direct the attention of the Trustees to what is already partially before the Trustees, viz.—the attempt upon the part of a Canal Company, to take possession of the River Clyde at and above the proposed new weir at Hutcheson's Bridge, and to make additional works in connection with that weir. The Committee have not been able to procure a sight of the plans of the works which the Canal Company propose to attach to the weir; but as the whole scheme implies the existence and continuance of a weir across the Clyde, the Committee trust the Clyde Trustees will not be consenting parties to any such scheme, but will oppose it with all their power and interest, and compel the Canal Company to terminate their works within the northern line of high water.

And the Committee farther recommend that a copy of this Report be sent to the Lords of the Admiralty, and another copy to the Tidal Harbour Commissioners.

Archd. M'Lellan, *Convener of Committee.*

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTE OF BRITISH ARCHITECTS.

January 26.—J. B. Papworth, V.P., in the Chair.

The Very Rev. W. Buckland, D.D., was elected an Honorary Member, and F. C. Penrose, Esq., an Associate.

A letter was read from Herr Zanth (honorary and corresponding member of the Institute), at Stutgard, descriptive of a Casino, now nearly completed from his design and under his superintendence, for the King of Wirtemburg. The structure—named after the royal owner, "Wilhelma," is of stone, in the Moresque style, the courses of the masonry being coloured white, yellow, and red violet, and covered with copper, partly gilt. It is situated in a winter garden, in the midst of four conservatories with porticoes, steps and terraces, and parterres;—it consists of a vestibule, an Oriental court, with a fountain, a picture gallery, a divan, a saloon, an eating-room and appurtenances, a sleeping and dressing room, and a bath with an arched roof, decorated with pendants. The conservatories and porticoes are of cast iron, very slender, and richly ornamented;—in the same taste, the conservatories divided into two aisles, containing various rare flowers, abut against two pavilions, surmounted by glazed octangular cupolas, for tropical plants;—the entire extent is about 350 feet; at the end of the conservatories the porticoes commence, which form the enclosure of a flower-garden, for the private use of the king.

Mr. C. Fowler, Fellow, on presenting some plans and designs relative to the proposed Thames Embankment and railway street, read a paper on the projected lines of railway in the metropolis about to be submitted to Parliament. Mr. Fowler stated that he was indebted for most of the details to Mr. Austin, the engineer (Hon. Secretary to the Metropolitan Improvement Society), who had been at considerable pains to prepare a plan of the whole of those lines for which the deposits had been completed. He need scarcely say, that there had been a number of other schemes, which had not survived the fatal effects of the panic; of those that remained, it appeared from the plan *that there were twenty-one different lines*, comprising 100 miles of proposed railway. within a circle of five miles from St. Paul's. The spaces scheduled for termini within a circle of fourteen miles of St. Paul's, together with that necessary for the construction of so much of the lines, constitute an area of little short of 200 acres, being equal to that portion of London extending from High-street, Whitechapel, to St. Paul's Cathedral, included between Leadenhall-street, Cornhill, the Poultry, and Cheapside, on the north, and the river Thames on the south: nearly equal to one-third of the City, and little less than one-half of that devastated by the conflagration of 1666. On a moderate calculation, it would involve the destruction of between 9,000 and 10,000 houses, and cause an expenditure, for the purchase of property alone, of about fifteen millions sterling. Mr. Fowler stated, that a memorial on the subject had been forwarded to the First Commissioner of Woods and Forests by the Metropolitan Improvement Society, suggesting that the Metropolitan Improvement Commission should take the subject into their consideration at an early period; and observed that it behoves not only all professional men, but all who desire to see a right direction given to this extraordinary movement, to assist in promoting the same in order that this branch of railway communication may be dealt with separately and distinctly, so that a comprehensive and systematic plan may result from what at present is a heap of confusion, arising from the fact that each line has been separately laid down, without reference to, or the knowledge of, what is proposed by any other. Mr. Fowler alluded to the new principle of railway streets, and to the double object that the Thames Embankment and Railway Junction Company had in view in adopting it, namely, that of carrying out a great public improvement in conjunction with the extension of railway communication; likewise that, in the event of Government acceding to a separate and distinct consideration of metropolitan lines, an opportunity was at present afforded which could never again occur of effecting the improvement of this great metropolis, as to salubrity, convenience, and splendour, without, probably, any sacrifice on the part of the Government. Mr. Fowler adverted to his design for carrying a railway over London-bridge, as one of the means proposed to connect the lines now terminated at the south end of the bridge with that projected through the City from Hungerford-market to the Blackwall line. This was proposed to be effected by the addition of arcades; covering the footways with iron framework, extended over the carriage-way to carry the rails: the former of these additions had been projected by him in one of the designs submitted to the House of Commons, when the reconstruction of the bridge was under consideration.

February 9.—Mr. Tite, V. P., in the Chair.

NEW MODEL OF THE PARTHENON.

A discussion took place which excited more than ordinary interest, and attracted a very crowded meeting of the members of the Institute, the subject being the consideration of certain questions respecting the original architecture of the Parthenon, suggested by Mr. Lucas's models recently deposited in the British Museum.

Mr. Lucas commenced the discussion by reading the following paper, of which he has obligingly furnished us with a copy.

Mr. President and Gentlemen,—I beg to offer you my best thanks for your obliging courtesy, in the opportunity thus afforded me of introducing the subject of the Restoration of the Parthenon, before it may be, the most severe, but at the same time certainly, the most competent tribunal—and I bring this subject before you with much anxiety, conscious as I am that the portion of my work you are most likely to sit in judgment on, is that to which my previous studies had been but cursorily directed, and but that I appear before you rather to court correction than to impart information, I should now feel as though I were bearding the lion in his own den. Sir, it is our lot to live at a period when improvements in every department of science have been carried to great results; and though in the fine arts, a commensurate development of successful energy is not yet apparent, the time is now come when the artists whose works are the most enduring chronicles of the great events of their period, should bestir themselves, for it cannot have escaped our observation, that within the last few years simultaneously and apparently without any connection, a general tendency to revive the study of high art has sprung up in the most intellectual parts of Europe, in Germany, England, Denmark, France—while in England, from many happy circumstances, art appears likely to assume a high position.

I have, Sir, in the course of my reading met with the observation that to have a difficult subject thoroughly investigated, we should set to the task one who has a fitting amount of natural qualifications, but who is entirely ignorant of the theme; place at his disposal all means and appliances of study, and if it be his aim (as mine is) to investigate solely for the production of the truth, you may then get the subject treated with all the zeal of the advocate, united to the calmness and sobriety of the judge, even though the subject matter be so important as the master work of Ictinus, or the profound science displayed in the triumph of Phidias; a theme so glorious immediately rouses in the mind of the investigator all the latent or dormant energies of his nature, with no inaccurate early impressions to remove from his mind, no erroneous foregone conclusions to bias his judgment, he surveys with ardour and enthusiasm, but records with calmness and indifference, untramelled by the vividness of early impressions; he is competent to seize and to analyze all the salient points of controversy, and to arrive by induction at sound conclusions.

But from this mode of proceeding one defect may be anticipated which ought to be guarded against, namely, that in investigating the details of an interesting subject, a few points already too partially investigated may be taken for granted, and therefore some matters not apparently important to the high bearings of the case may be overlooked or underrated; but it is my good fortune to introduce the result of my labours where the spirit of them will be fairly appreciated, will for minor blemishes not materially effect the whole performance in its general appeal to the understanding, and I am sure that you, Sir, will always appreciate a work according to its merits, and judge the artist with respect to his intentions, and the peculiar circumstances under which his work was executed. Our subject, Sir, appears naturally to resolve itself into a recapitulation of the known and admitted facts of the case, including its general history, architectural construction and sculptural adornments, with a consideration of the doubtful or uncertain portions, included in which is to be placed the question relative to the interior of the Temple, its polychromatic adjuncts, the Chrys-elephantine statue of the Goddess, the central portion of Eastern Pediment, with the missing metopes frieze-shields, &c. and having examined these matters I propose very briefly to investigate the principles that guided these great artists in the adornment of their works. It is necessary for the unity of the subject I should notice the known parts, but only very briefly.

It is well known that the Parthenon was erected at Athens about B.C. 440, in the most flourishing and glorious period of that great republic, under the auspices of her greatest statesman, Pericles, and from the designs of the greatest sculptor and of the most celebrated architect of the ancient world, Phidias and Ictinus. It stood on the summit of the Acropolis, was a Doric temple, 227 feet in length on the upper step, by 101 feet in breadth. It was constructed entirely of Pentelic marble, and, including a stylobate of four steps, was 66 feet in height; it was called Hecatompedon, or the building of a hundred feet; and from its united excellencies of design, decoration and material resulting from the fine taste, unbounded means and munificence of Pericles, it may be recorded as the most perfect that was ever executed. In the Parthenon was consummated the noble triple union of architecture, sculpture and painting; in it was the artist's triumph complete, and art reached its acmè.

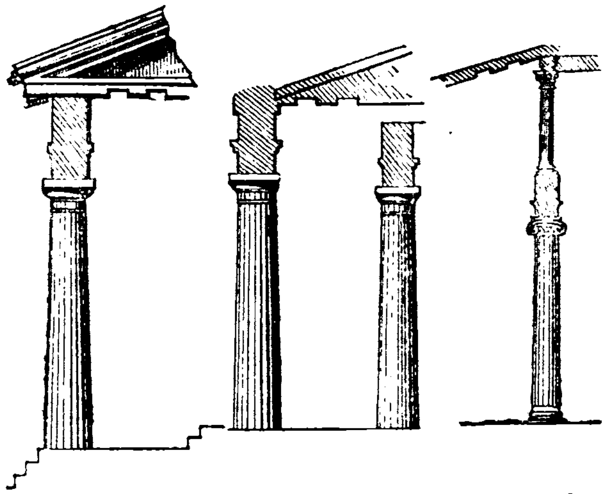
In the construction of the columns of the exterior much subtlety of management appears to have been used, such as the well known facts of the inclination of the columns 1½ inch inwards, and that of the outer or angular ones of the exterior being larger by 2½ inches diameter than the others; and I have also been informed that the enstasis or swell is dissimilar in the different columns, and that the diameters of others besides the end ones are also different; but the most curious circumstance is the last I have heard, and which I believe a talented member of your Institute, recently arrived from Athens, can testify to you, viz., that *all the capitals* on the south side of the temple are 6 inches smaller than any others, and I hope also now to learn if the diminution of these capitals be confined to the ovolo under it, or whether it serve to increase the entasis of the columns generally; other further peculiarities of structure may here be alluded to. Mr. J. Pennethorne in his work observes, that he found the upper step of the Parthenon to form a simple curve rising 3 inches in the centre, that higher in the front the curve changes its character, and in the architrave becomes a curve of a double curvature. And Mr. Bracebridge informed me that on stretching a string from the two ends of the front lower steps he found that the centre of it receded two inches from the string.

[Mr. Lucas then detailed at some length the history of the Parthenon from the time when the Acropolis was beseiged by the Venetians in 1687, to the time of Lord Elgin—the general character of the sculpture, &c., but as these points are fully considered in Mr. Lucas's published observations, they are here omitted. After a minute examination of the designs of the sculpture in the pediment, the lecturer proceeded as follows.]

In restoring the Parthenon the question that is most difficult to grapple with, and least likely to be successfully investigated, is the interior of the Temple, it having undergone so many transformations, each possibly leaving some trace or vestige, and those vestiges so comminated together that little satisfactory information can be expected to result from the most determined application. Those most competent to judge on this matter generally arrive at different conclusions. As regards the roof, some suppose it was open, and others that it was entirely closed, and that the natural light of the heavens was supplied by artificial light, but both these suppositions appear to be untenable; the open roof hypothesis being met by an ancient epigram on the statue of Jupiter in ivory and gold, in a temple similar to the Parthenon, namely, that *if the god rose he would carry the roof with him;* while the entire closing the roof and consequent exclusion of the best light for a statue, the light of day, seems very improbable. A partial opening admitting light, by the means of some semi-transparent substance, appears in the absence of all proof the most feasible supposition.

As to the columns that supported the roof equal obscurity exists, the most probable supposition being the last one on the subject, and which has only been lately brought to light on destroying the mosque, in 1844. M. Pittakis, in a letter to me on the subject, gives it as his belief, that the traces of Doric columns found on this removal of the mosque, with a diameter of five feet, supported an upper tier of the Ionic order. This statement of the diameter of the lower or Doric tier, being of the proportions of five feet in diameter, is confirmed by the personal observations of Mr. Bracebridge, and of Mr. Penrose. On the other hand, in letters read at this Institution, from Mr. Knowles, a month since, the diameter is given at 3ft. 7½ in. I am at a loss to account for this great discrepancy on a subject so interesting, and apparently so easy to be ascertained. Now admitting the Doric to have been the original structure, and five feet the diameter, it then appears from the following diagram that there would be no space for an upper tier, for if it be an Ionic one, it must have been disproportionately small compared with the bulky Doric below. Supposing the Doric to have been used, I am rather disposed to believe that an upper tier could not have been used, but that some other architectural feature must here be substituted.

No. 1. No. 2. No. 3. No. 4.



6 feet 2. 5 feet 6. 5 feet. 3 feet 6.

No. 1 Outer Column.—No. 2 Column of the Pronaus.—No. 3 Size of the traces of Columns lately discovered.—No. 4. The arrangement of the interior in the restoration.

With regard to the chief sources of authentic information as to the use of colours by the ancients, the subject has been exhausted by the able remarks of the various writers on this matter; Mr. Hamilton, in his translation of the report of the committee who investigated the marbles of the Parthenon, appears to have had no bias on the subject, and the inferences I derive from his translation are, that some of the early temples must have been white, and that others were certainly painted, but no hint is given as to the period, and as to the actual tints on the most perfect specimens of remaining colour in the temple of Theseus, Semper found some blue colour under the necks of one of the antæ, and therefore drew the conclusion that the whole of the wall of the cella was blue. Scheubert on the other hand says he found on the same spot colour, and that it was yellow, and yellow in his opinion was the colour of the cella. Another observer found what he considered red, and draws similar conclusions. But although this discrepancy exists on this point, all agree in stating that above and below the frieze, in the Parthenon, the meander ornament was painted in a reddish brown. On that brown, gold has been discovered, and therefore some suppose the colour to have been the ground for the gold, and this also applies to the elegant palm leaves, on the facia, below the triglyphs and the ornament on the pediment.

Admitting as we must, from the amount of evidence that the Greeks did use much colour on their works, yet with regard to the actual mode of applying it, or the period of its most general use, we are in a state of great uncertainty.

It has been observed respecting the purity or impurity of taste in the use of colour by the Greeks, that this consideration was foreign to a restoration, that it was for us to decide on the question by the proofs as adduced, and that in restoring we must restore colour as *demonstrated*, and that we have no right to set any fastidious idea of our own in the use of colour in opposition to the practice of the Greeks, where that practice admits of proof. To this however I would beg to demur, that from our practice in the use of colour, we have no right to assume, that the ancient Greeks used colour as we now apply it, especially in their application of it to their highest uses in painting their divinities. We have it in evidence that the columns of the Parthenon were painted red, but the circumstance that the paint exists in the *opening of the joints* of the columns demonstrates that the colour was applied at a late period, subsequent perhaps to some earthquake or other commotion, because on the completion of the temple the joints were so close as to prevent the insertion of colour. Now it does appear to me, that of a style of art so severe and chaste as the architecture and sculpture of the Parthenon, the high excellence can only be comprehended and appreciated, by our having still in existence enough of the precious fragments to form some conception of the effects of the whole. What kind of idea could we have formed of the architecture and sculpture from mere description or fragmentary evidence? Let us reflect—what idea does our own art give us of the perfection of Greek art, except as a close imitation of that which actually exists. Without the actual work of the Greek artists before us, who could have propounded any resuscitation of its high excellence either in form or execution? And in like manner from the nature of things, I am entitled to contend that in the best times of Greek art, where colour was applied, it was used with equal severity, chastity, skill and purity, as the sculpture and architecture demonstrate, and therefore reasoning from analogy as from fragments alone, we could not hope to restore as a whole, neither can we in colour hope to reconstruct with our limited opportunity of observing, not so much perhaps as to the actual tints as to the mechanical application of them, after the beautiful sculpture had received all its wonderful discriminative touches, the marking of bone, tendon and muscle. Does it seem probable that men of such cultivated tastes would have smeared over these highly wrought forms with oil and earth? Does it not, Sir, seem more probable that the surface was *stained* with colour, not coated with a pigment? in using colour to embody the forms of their deities, we may be assured that the same amount of skill, pure taste, and beautiful appliance would be used as was shown in producing and finishing the actual form. Viewed in this light, it is by the power of the imagination, and this power alone, that we of these latter days can comprehend the glorious aspect of the Parthenon, in its integrity of colour as well as form. It may be that my bias may render me an incompetent judge on this subject, but I have searched with much assiduity, and I believe that all the colour I have seen results from the surface being stained, not painted. In some parts colour remaining, shews the pure surface of the marble where it has been protected by the pediment; and where exposed. In some parts the original surface is still preserved by the means applied to tint it, and as the other surrounding portions are deeply corroded by time or drip, so I believe that the process of tinting hardened and preserved the semi-transparency of the marble; and of that mode of execution as applied to sculpture, I do not think we have acquired the secret.

Having thus briefly explained the structure and decorations of the Parthenon, we proceed in our endeavours to investigate the principles of design that characterise this great work of Phidias and Ictinus. The effect which their work creates on our minds appears everywhere to be produced by the same means,—variety and contrast in unity—whether in its architectural construction, in the selection of the subjects for the sculptures, or in their composition and treatment. In the architecture, the solemn and rigorous uniformity of its masses, and the severe proportions of the columns, contrast marvellously with the boundless diversity of the lines of the sculpture. And while unity is thus preserved by the symmetrical character of the whole structure, clearly and intelligibly stated to the eye, and commanding the observance of the mind, the attention is enchained and preserved by the beautiful and harmonious play of light and shade resulting from the inner columns of the pronaus being smaller than the outer, and being placed on steps, which carry the inner architrave higher than the outer. The beautiful frieze is thus placed above the spectator's first glance, and reserves for him beauties veiled from his first impression, and therefore far more effective in their unobtrusive display at the proper period.

It was thus, by an inexhaustible power of invention that Phidias produced that great impression, which all minds gifted with a perception of the beautiful acknowledge, in the contemplation of the Parthenon; and, for ourselves, let it be our study to dwell on these noble works, and to seek to imbue ourselves with their spirit and power, in the choice of noble theme, in composition and treatment. This, then, is the proper influence these noble examples should exercise on our art, to produce a truly National School of Sculpture; for we cannot be blind to the circumstance, that merely repeating the *forms* of Greek art; must altogether fail in producing such a desideratum. Greek art was perfect because it was national, because its peculiarities suited alike the national feeling and the national religion. An attempt to repeat the mere forms, whether united to their myths or without that appendage, must fail to satisfy in any department of art, as far as regards the producing an English School, either in poetry or sculpture, painting or architecture; yet the contemplation of the myths of the Greeks is full of interest and use, as adding to the amount of our knowledge of the operations of the human mind, and here we may learn how man sometimes produces results so perfect as to become laws, and as it were to form an eternal model of fitness and propriety, the result of wants perfectly supplied, of ideas perfectly embodied, of national feelings incorporated with and represented by national emblems.

It requires indeed a considerable knowledge of Greek art to be able to appreciate the full amount of influence it may exercise, and a still more thorough acquaintance with their works, to comprehend their real scope and depth, and it is not therefore surprising that a high general estimate of this art should prevail, and yet that it should be but little understood, or that its influence should *be limited.* It may be said—what are the excellencies we are to seek and to use, to form as it were part of our nationality? I answer the general comprehensiveness of plan, its fitness, its grandeur, its profound science, and general nobility of treatment, so unlike the meanness of plan, rigidity and utter prostration of science, so often discoverable in works, produced out of the pale of Greek art.

The whole chain of dependent facts was evolved and laid out to be examined; the most delicate shades of truth scrupulously distinguished, and as no science can exist without demonstration, the whole existed as one. *Architecture* and *Sculpture*, and *Painting* blended into consummate harmony: the Parthenon was a magnificent poem, comprehended at a glance, and in this poem of a thousand stanzas, every separate verse was a poem in itself, but subdued and aiding to the general effects by the fitness of its application, and the harmony of its proportion. This accurate systematic form which gives to Greek art its utility as an example, indeed is to be found no where else, and without it we cannot understand the science of art in its truth. Now to speak of a general system as applied to Mediæval art sounds rather curious. I speak here of the adornments rather than construction; they seem a collection of fragments—here a consistency, there an absurdity, hint and hypothesis, doubt and dogmatism, feeling and reason, cold mathematical *abstraction*, and the most gorgeous poetry, the drama and the lecture, the serious and the ridiculous, all thrown together by a hand careless in its profusion of riches, both disjointed, and constituted—these are the characteristics of the most perfect specimens of Mediæval art, and in this art they often seem to have overlooked that great advantage in Greek art, the exquisite beauty of their forms. Whether it was climate or natural temperature, or education, or social circumstances that gave the Greeks their delicate perceptions of universal beauty, no people ever existed in whose happiness it was so necessary an ingredient, or to whom it was so profusely ministered by the genius of their composers. Their whole nature was so refined that truth stripped of grace and beauty, could no more touch their minds than religion their hearts, unless veiled under a gorgeous mythology.

The Greeks succeeded in producing perfection in the art or science of pourtraying the human form in its most perfect beauty: this we also must use; for without it our art must retrograde. But we require something more than the science of beautiful form: we must use the form, and superadd a spirit of nationality. The sculpture of the ancients is the most faithful, the most eloquent, the most enduring chronicle of their greatness. If, in his solemn discourse over those slain in battle for their country, Pericles could say that *of illustrious men all earth was their tomb, and that their names were not merely graven on the sepulchral marble among their own kindred, but stored up for ever, in the unwritten registers of memory in other lands;* so may we say, at the close of this our essay on Phidias, that though the glory of it, manifested to his countrymen in distinct and familiar characters and in the fulness of its meaning, is to our distant age only dimly and distantly revealed; if we know it only by the few fragments we have preserved, or by those scattered in foreign lands, or by cold delineations and still colder descriptions, yet the image of the art survives in the mind of man, to be reflected again and again in the thought of remote posterity, an unwritten record and silent witness of the greatness of the Athenian people, and the genius of their sculptor.

"They so sepulchered in such pomp do lie,
That kings for such a tomb might wish to die."

When Mr. Lucas had finished, Mr. Donaldson read the following remarks:

You will doubtless, gentlemen, have been struck with the energy and fixedness of purpose with which Mr. Lucas has followed up his project of working out a reputation for himself by a restoration of the Parthenon, the fame of which, he hoped, would bring him favourably before the notice of the public, and no less pleased by the frankness with which he has communicated to us his ideas on the subject.

But there are other considerations of very great importance, which offer themselves in connection with so vast an undertaking. The boldness of the attempt must be justified by the qualifications of the enterprising artist. The taste and practical skill of the sculptor must be seconded by the learning of the antiquary, the professional experience of the architect, and the precision of the modeller. It seems beyond the range of human probability, that any thing less than a visit to this noblest of ancient monuments, and many weeks, nay months, devoted to the study of it on the spot, could enable any one, however gifted, to solve satisfactorily the many doubtful questions which hang over its complete restoration. We know that Palladio thrice visited Rome ere he ventured to publish his monuments of Roman architecture. Brunelleschi returned again and again to study the baths, the temples, and the ruins of that ancient city ere he felt satisfied to undertake the construction of the dome of Santa Maria dei Fiori, at Florence. Mazois repeatedly went to Naples to measure and draw the remains of Pompeii, in order to ensure a scrupulous and faithful record of the excavated buildings.

If Mr. Lucas had published his model and descriptions of it, as a restoration of the *sculptures* of the Parthenon, if the laudatory paragraphs, inserted by his admirers and friends in the public prints, had confined their eulogies to this, and had laid no higher claim than to the merit of having restored the work of the immortal Phidias, I should have left to others more competent than myself, and better acquainted with that sister art, to have examined into the proprieties of the restoration in that department. But the title-page of Mr. Lucas's own pamphlet, copies of which we owe to his friendly courtesy, states that one of the models exhibits *the temple as it appeared in its dilapidated state in the seventeenth century, and executed from the existing remains, or from authentic drawings.* The other *being an attempt to restore it to the fulness of its original beauty and splendour.* It is upon the fallacy of these statements, as regards its architecture, that I feel obliged at once to protest against the models—the one as not being a faithful representation of it in its dilapidated state, not executed from existing remains nor from authentic drawings—the other being inaccurate generally in its architectural details, and being *deficient*, instead of exhibiting the *fulness* of its original beauty and splendour.

I feel called upon to examine the subject thus specially, for the architectural errors are so contrary to the canons of the art, that the character of the profession is implicated, when we see that the Trustees of the British Museum give the stamp of approbation to these mistakes by purchasing the models, and exhibiting them in juxta-position with the very marbles of the Parthenon itself. We must give them full credit for wishing to do full justice to the high reputation of Phidias; it is only to be regretted that, from parsimony or ignorance in themselves or those around them, they should have forgotten the claim of Ictinus to the character of the first architect of his own or any age, and as having produced in the Parthenon a work free from every defect, pure in every detail, graceful in every proportion.

In the model of the Parthenon in its dilapidated state, Mr. Lucas has erroneously represented on the architrave over the columns of the Posticum, the fillet caps over the guttæ. He has not placed them at the angles, and has continued them along the flanks. They now exist at the angles, and at equal spaces along the front, as shown by Stuart, and there were none as usual along the flank.

Mr. Lucas has continued the antæ cap mouldings along the wall of the Posticum, and along the flank wall of the cella, in both which positions they never existed. Mr. Lucas has represented cornices on the inner face of the cella wall where they do not exist, nor according to the most probable mode of restoration, ever could exist.

These introductions are totally at variance with the drawings of Stuart, and cannot possibly be extant in any other authentic drawings as stated in the title-page of the pamphlet.

I must now venture to allude to the restored model. In the first place, it is less accurate as regards the steps, than that of the ruined temple. In the latter there are only three, in the former four. Upon referring to my own studies made on the spot, I find three steps of marble, and below the lowermost a slab of the same height and about the same projection of stone, and thus specifically stated in my sketch. There is then a much wider slab of stone, and a drop beyond of 3 ft. 4 in. It appeared conclusive to my mind, that the stone slab was a portion of the pavement of the area around the temple, which was laid with slabs of stone, the upper surface being level with the upper face of the stone slab under the third marble step. In fact, it would have looked incongruous to have had one step of stone and then three of marble. Besides which we have the testimony of Vitruvius, who says, Book III. c. 3. "The number of steps in front *should always be odd*, since in that case the right foot, which begins the ascent will be that which first alights on the landing of the temple." We know that our great master borrowed all his canons from the Greeks, and that the superstitions of the ancients had a common origin and a common acceptation.

The restored model shows no traces of the plinth which existed between the lower parts of the columns of the Posticum, and of which there are indisputable signs in the Parthenon. This plinth, which was 9 feet 1 inch high, and half as wide again as the centre fluting, received the standards of the metal grating which inclosed the intercolumniations up to the summit of the capitals, as is ascertained by the mortice holes still existing in the antæ. This metal work was for the purpose of giving security to the Posticum, as within it were exposed to public view many of the votive offerings of beauty and value, the riches of the temple, and being placed within the metal railing, they were prevented being injured by accident or purloined by the evil disposed. This grating was probably of bronze gilt, and many Roman bas-reliefs offer authority for a restoration.

The next inaccuracy to which I wish to call attention, is the doorway. The old aperture had been narrowed long since, either by the Venetians or Turks, by the introduction of slabs in irregular courses; beyond these slabs the wall is perfectly plain. Reasoning from the magnificence and importance of the Parthenon, which would be evidently deficient in effect if the doorway were a mere square aperture; reasoning from the analogy of the Erectheum, which has a magnificent doorway, although an edifice of less importance than the Temple of Minerva, and reasoning from the evidence to be found on the apertures of the Propylea, which had evidently bronze dressings, I have little hesitation in stating my opinion, that the dressings of the Parthenon were of bronze, and that the model is singularly unfortunate in having consoles or trusses, which support nothing, are accompanied by no corresponding embellishment, and are contrary to all reason, propriety, and example. I have already alluded to the continuation of the mouldings of the antæ caps, retained in the restoration, and quite contrary to fact. We now come to the interior of the cella, and considering the complexity of the opinions offered by Messrs. Pittakis, Finlay, and others, who were consulted by our author, it is not surprising that he should have found himself involved in a maze of difficulty. It appears that Mr. Cockerell, in the seventh volume of the Museum Publications, has restored the interior with two orders of columns; the lower are Corinthian, the upper are Doric. All the rules of the art, all analogy, and all probability have run counter to this daring arrangement. In the temples of Pæstum we find a double tier of columns, one over the other, to support the roof of the hypethrum, both Doric; but the casual statement of Mr. Inwood, that a portion of a Corinthian capital was brought by him from the Parthenon, and a similar fragment discovered in the Temple of Apollo Epicurius, at Bassæ, near Phigalia, seem to have been considered sufficiently grave authority for the introduction of the Corinthian, as one of the inner orders of the Parthenon. Assuming at once that Mr. Inwood got it from the Parthenon—How did it get there? Was it there originally? Had any other traveller—the precise Spon and Wheller, or the laborious Stuart and Revett ever seen it? Among the strange metamorphoses by Venetian, Turk, and Greek, may it not have been converted to the purpose of construction from some stray fragment beyond the verge of the Parthenon, as being lighter and more easily applicable for their purpose than the ponderous blocks of the construction of Ictinus? May it not have been purposely placed there by some wily Greek to give it additional value in the eyes of one, who was eager for any fragment of Attic art, and profusely liberal to every one who contributed to his collection? The introduction of the Corinthian order into the Parthenon involves so many serious questions in the art, that its adoption must rest upon some more authentic proof than that which accompanied this questionable fragment. But let us assume that it came from the Parthenon, and was always there; is it too much to require the restorer to pause and consider whether this may not have been a fragment from some object quite distinct from the architecture? for we know, from Pausanius, that all the Greek temples of any size and reputation were filled with statues, groups, pedestals, candelabra, ears, tazzæ, tripods, vases, seats, and other articles of wood, metal, and bronze; the votive offerings of the conqueror, the supplicant, and the superstitious. Mr. Lucas has introduced the Ionic as his lower order, and the Corinthian above; a restoration more consistent with our preconceived notions, yet still open to serious objection. However, he has given a regular entablature to his lower order, whereas, judging from the Pæstan Temple, and the reason of the thing, a mere architrave or beam were more fitting. But a more serious objection presents itself in the arrangement of the ceiling, which is made to overhang the upper range of columns for the purpose of contracting the aperture of the hypethrum. This presents so much difficulty of construction, and seems so much in advance of the science of the Greeks at that period, that I cannot but consider it as apocryphal, as also the pedimental form of some of the compartments of the ceiling, and the sloping roof over the aisles of the cella.

I have not wished to lengthen my remarks by allusions in detail to some questionable portions of the sculpture. I may, perhaps, be venturing on ground for which I am as little qualified to judge, as Mr. Lucas is to form an opinion of the architecture: but I must own, that I could have wished that the sculpture had been modelled with a refinement and finish more corresponding with the exquisite execution of the matchless original. I could have wished that one's ideas of the dignity, the splendour, and proportion of the Chrys-elephantine statue, and the grave majesty and beauty of Minerva herself had been more realized than it is in this conception; and it appears to me that the want of pure drawing, the total absence of Attic elegance and correct proportion in the rude illustrations of his pamphlet, do little justice to the intelligence of the author in the letter-press. I could have desired that the modelling and putting together of the architectural details had been less characterised by coarseness and want of delicacy. And I must own, that the prominence given to the sculptures of the pediments, the projections of the heads and limbs of so many of the figures, seem to me so much to interfere with the lines of the architecture, and themselves to be so much cut up by the intersection of the corona, as to produce a most unsatisfactory intricacy, and disagreeable contrast. Neither the drawings of Carry (perspective views taken from a low point), nor the casual signs of a water drip, which may have arisen from a misplaced slab above, nor the solitary instance of a questionable indentation of a fragment head—more than probably a rebate to receive the bronze helmet, nor the projection of the horse's jaw at a part where no shadow broke the continuous line of light, seems to me to justify the solitary instance of so marked a principle, which would have itself established a rule in all future cases, but which has never, that I am aware, been followed in any succeeding instances in ancient or modern times, that have pretensions to be considered as classic works of art. I shall conclude with one more reference, and that is to the polychromatic embellishments timidly indicated over certain parts. Mr. Lucas states, that he is not called upon to run any risk of making a *gaud* of this restoration of the Parthenon, or to depart from the severe simplicity, which is the characteristic of all the art of Phidias. The testimony of tradition as recorded in the Transactions of this Institute, the evidence on the monument itself, the fragments recently dug up, all prove that polychromy had its full development in the Parthenon. The fragments discovered in the foundations, attested the antiquity of the practice. Will Mr. Lucas venture to say, that the Parthenon, when so embellished, was a gaud? Will he assume the question, and say that the simplicity characteristic of all the art of Phidias was colourless? What is the testimony borne by the monuments of ancient Egyptian architecture? What by the productions of mediæval art?

If, in regard to the extent of polychromatic embellishment, Mr. Lucas hesitated among conflicting opinions to go to the full extent of some of the advocates for unqualified adoption of colour, I could understand his prudence; but it seems equally rash to reject all colour as to adopt it throughout: and reasoning does not seem to justify the introduction of colour in one or two parts only, which by their very solitariness contrast most harshly with the rest of the model.

In submitting to your notice these observations upon these models, I have felt called upon to do so, in order to vindicate the professional character of the English architect, which is perrilled by the conspicuous position given to a work of art, professing to be a restoration of the noblest monument of antiquity, and uniting the knowledge, science, and learning of this country. The accuracy of the English architect has been acquired by many personal sacrifices, laborious investigations, and pains-taking accuracy. The work of Stuart and the productions of the Dilettanti Society, had established the fame of the English, as the revivers and best illustrators of Greek art. But what will be the opinion of foreigners upon English architects, if this defective and erroneous restoration be assumed, as the proof by which to estimate the research, and knowledge, and skill of the English architect in 1846. In this I do not so much allude to Mr. Lucas, as to the Trustees of the British Museum. Mr. Lucas has been imprudent in calling this a restoration of the Parthenon in all the *fulness* of its original *beauty and splendour*. He has looked at it merely as a sculptor; and the architecture he has considered as subordinate to that his first object. The Trustees should have called in the advice of some one or more of the many architects who have measured the Parthenon stone by stone. They should have provided Mr. Lucas with the most perfect model of the building that modern research could have produced; and our sculptor could have worked on his restoration of the sculpture, unembarassed by considerations of the details of the architecture, for which he was neither prepared nor fitted by previous study, as he has himself modestly avowed.

I now conclude these remarks, put together in the brief interval of numerous and important professional avocations, not to detract from the merit of Mr. Lucas's courageous attempt, but, as I have said before, to vindicate my profession from the imputation of those unfortunate blemishes, which, although they may not affect the reputation of the author as a sculptor, seriously peril the fame of the English architect, scholar, and antiquary, in the estimation of the accomplished and learned foreign artists of Europe.

Mr. Lucas in reply, observed that he felt much indebted to Mr. Donaldson for his valuable suggestions, and for the obliging manner in which they were conveyed. He was not prepared to accede to the propriety of all the alterations proposed by that gentleman, but he readily allowed that in several points his own opinions were modified by what he had just heard. Much applause was expressed by the meeting at the frank manner in which Mr. Lucas made this avowal. He said that with respect to the introduction of four steps instead of three at the base of the temple, he had been guided by the authority of Colonel Leake. In the small model which was made as a preliminary to the execution of the larger work now in the British Museum, there were but three steps: but the alteration had been made in consequence of the statement in Colonel Leake's book, that the number was four, and his determination had been confirmed by a letter which he had received from Mr. Walter Grenville, stating that there was a fourth step now obscured by rubbish. He felt however the full force of Mr. Donaldson's argument, and in fact he had, from an anticipation that an objection might be made on this point, so arranged his model that the requisite alteration could be immediately effected if he should hereafter feel himself sufficiently authorised in making it.

With respect to the continuation of the mouldings of the antæ all round the temple, he had been guided by the drawings of Stuart. As the fascia and string course certainly went all round, and as in the plates published by Stuart, the lines beneath those members were also drawn as continued, he considered that he had accurately interpreted the intention of the drawings by the arrangement observed in the model. It was also necessary to observe that his original models had been submitted to the inspection of many highly competent persons, but though he was indebted to them for several valuable suggestions, no objections had been expressed as to the particular architectural features in question.

With respect to the strictures on the inclination of the doorway and the form of the consoles, he had no defence to offer. He was convinced of the propriety of Mr. Donaldson's remarks, and intended to adopt his suggestions. With respect however to the introduction of railings at the entrance he could not express the same concurrence. It appeared to him that these features were purely matters of detail, and it was obvious that there were many mere details of the interior which it would be not only impossible, but improper also, to represent in a model. In cases of this kind, especially where the artist had no guide from the remains of ancient fragments, some liberty must be given to him of using his own discretion. It certainly appeared to him that the railings in question might be with propriety omitted.

The first part of his work which he had finished was the Chrys-elephantine statue of the goddess. In the course of this work the idea had occurred to him of making a model of the temple, but he had originally entertained no higher aim than that of making the model a sort of cover for his statue. He observed that he agreed with Mr. Donaldson in not liking the present statue, and had pledged himself, without solicitation, to the trustees to replace it by another containing the result of his latter experience. The objection that he had made, that some parts of the sculpture in the pediment intersected and protruded beyond the corona, and had thereby broken the continuity of the cornice, was the objection of an architect rather than of a sculptor. His answer was this—on examining the shoulder of the Ilissus, it would be found that this part of the statue was marked and worn by the constant dripping of water, and it was therefore clear that this part of the figure could not have been sheltered by the projection of the cornice. The Ilissus was only a fragment, still from the attitude it could at once be seen that the head must have been higher and more forward than the shoulder; and as the shoulder must have been, at the very least on a line with the cornice, the head must have projected considerably beyond it. His reasoning was confirmed by the drawings of Carrey, who had represented the sculpture as intersecting the line of the cornice. The case of the Ilissus was by no means a solitary one, as, for instance, the horse's head and the fragment of the head of the Minerva of the western pediment, and Carrey represented the same state of thing as existing in numerous instances throughout the temple. Mr. Lucas said he was therefore by no means prepared to assent to any change in this respect, but firmly maintained his original opinion.

He had made preparations for shortly visiting and minutely examining the temple. He felt very much indebted to the Institute for the suggestions which had been expressed there, and for the manner in which his explanation had been received. His great and anxious desire was to render the model as perfect as possible, and he earnestly assured the members that he was desirous of hearing every objection that could possibly be brought against it, as by these means errors would be corrected and doubtful points as far as possible explained. For his own part, he promised that no effort should be wanting towards the fulfilment of these important objects.

The PRESIDENT expressed in warm terms the obligation of the society to Mr. Lucas and Mr. Donaldson for the information which they had afforded. He would observe respecting the railings of the Opisthodomus, that as that part of the temple served as the treasury, and contained the votive offerings which were of immense value, it seemed necessary that it should be guarded by railings, and he thought they might properly be represented in the model. He invited Mr. Lucas to examine some models of the Parthenon in his own possession, which had been made by a gentleman who had measured every square inch of the ground. A great benefit arising from the exhibition of Mr. Lucas's models would be the enlightenment of public taste, and the illustration it would afford to those not conversant with architecture, of the form of the Parthenon. He was convinced that many who visited the British Museum, had an impression that the Elgin Marbles were hung round the interior walls of a room resembling that in which the remains are now deposited. The new model would serve to correct this error. The President concluded by expressing in very happy terms the thanks of the meeting for the papers which had just been read.

Mr. DONALDSON said that he must make one remark before the meeting separated. He trusted that the Institute would render every assistance to Mr. Lucas in the investigation which he was about to commence, and would use its influence with the Trustees of the British Museum, that they might liberally offer to Mr. Lucas every possible facility and assistance in the prosecution of his undertaking.

Feb. 23, Mr. TITE, V. P., in the Chair.

Mr. Penrose read a paper on the entasis and other carved lines observed in the architecture of the Parthenon, but as the paper of Mr. Lucas, on a somewhat similar subject occupies a large part of our present number, we must defer the report of Mr. Penrose's paper till next month.

ROYAL SCOTTISH SOCIETY OF ARTS.

January 26.—The PRESIDENT in the chair.

The following communications were made:—

In place of Mr. Lawson's Paper on Hurricanes, which was postponed till next meeting, the Secretary gave an Account of Mr. Jacob Owen's (of Ireland) Paper on the Results of Experiments on the relative Strength of different forms of Retaining Walls.

2. *Accounts of some Experiments on Electro and Galvano Culture.* By WILLIAM FRASER, Esq., Aberdeen. In this Paper, Mr. Fraser gave an account of the results of numerous experiments he had made on the effects of electricity and galvanism on the growth of seeds and vegetables. In one set of experiments, he had passed a current of electricity through the seeds before sowing, and in others, he passed the galvanic current through the earth in which the seeds were sown, and he also applied it to the plants. He experimented in various ways, but with no benefit to vegetation, either from electricity or galvanism; for, although the seeds through which he had passed a current of electricity previously to sowing, sprung up quicker than those not subjected to that process, just as seeds do which have been previously steeped in water, yet, after a while no perceptible difference could be seen betwixt the plants from electrified seed and those from seed not subjected to that process. Mr. Fraser, in conclusion, suggests the form of an apparatus by which he thinks, it could be clearly seen whether galvanism produces any benificial effect upon plants.

3. *Description of a Drawing of a Horizontal Condensing Pump, for horizontal condensing Steam Engines.* By Mr. WILLIAM D. MEIKLEJOHN. In this condensing pump, Mr. Meiklejohn states that the condensation will take place much more rapidly, and that there would be a very considerable saving in the first cost of the condenser.

4. *On a Substitute for Railway Bridges.* By Mr. JAMES MILLER, Watchmaker, Perth. Mr. Miller submits, that in small bridges for railways there is too great a rigidity, when built of stone or brick, and that they are liable to be destroyed by their want of elasticity, and their not yielding to the vibration of the train; and he suggests that they should be made of strong rings of iron, upon which longitudinal iron bars should be rivetted—somewhat in the form of a cooper's chaûffer. They could be made at a distance, in pieces, and carried to the spot, and there bolted together.

February 9.—GEORGE WILSON, M.D., F.R.S.E., in the chair.

The following communications were made:—

1. *Description of a New Clock, impelled by a combination of Gravitation and Electro-Magnetism. Invented by* Mr. ALEXANDER BRYSON, Chronometer, Watch, and Clock Maker, Edinburgh. In this clock the common pendulum is used. It is kept vibrating, in equal arcs, by a small falling bar, or detent, which is raised every second by the attraction induced in a soft electro-magnet. The magnetism is excited by constant batteries placed in the bottom of the clock-case, which may be kept in action for any desirable period, and when changed it is not necessary to stop the clock; as before the spent battery is out of action, the other, which is newly charged, is in full operation. The wheel work, showing minutes and seconds, is moved by the gravitating bar or detent immediately on its being attracted by the electro-magnet. When this clock is made to show minutes and seconds only, as in observatory clocks, it consists of two wheels only, and when it is made to show hours, three wheels are necessary. The contact-breaker is suspended on knife-edges immediately above the pendulum bob, having a gold concentric arc, on which press two very slight gold springs. In this arc is inserted a piece of ivory, which breaks the current, and permits the falling bar or detent to fall on the pendulum so as to keep up its vibration. By the method of coincidences it was stated, the pendulum was found to keep its motion with the utmost steadiness, as compared with a compensation mercurial pendulum beating seconds.

2. *On the Causes of Hurricanes in the West Indies, with illustrative Diagrams.* By ROBERT LAWSON, Esq., Assistant-Surgeon, 47th Regiment. Communicated by Alexander Bryson, Esq. In this paper Mr. Lawson gives further instances, both from personal and recorded experience, of hurricanes in the West Indies, exhibiting phenomena not conformable to the laws of Hare, Espy, Reid, or Redfield; and while adopting as true many points insisted on by these eminent observers, endeavours to prove the dependence of those mighty convulsions on the moon's influence, which seem to have escaped all observers in this field of inquiry except the indefatigable Howard.

3. *Description, illustrated with Drawings, of an Improved Method of Manufacturing Pyroxilic Spirit (Wood Naphtha of Commerce), Pyroligneous Acid, and other products, from the destructive distillation of Wood.* By Captain GEORGE DACRES PATERSON. This communication contained a description of the manufacture of Pyroxile Spirit and Pyrolignite of Lime, with various improvements, the principal of which consisted in a new manner of stifling the charcoal, so as to free it from the noxious gases, and in the distillation, which is conducted on the principle of distillation *in vacuo*. The arrangements were stated to effect great saving in fuel and labour. The vacuum is formed by steam, and by a simple arrangement the condensed vapour is entirely drained off from the still prior, to the supply of liquor being forced up from the charging Back. A simple apparatus was described for guiding the workmen as to the different strength of the liquor; and a plan of a rectifier, by which the essential oil is more easily separated from the spirit, was also given, by which means, and others farther described, the Pyroxilc Spirit, it was stated, could be procured in great purity.

SOCIETY OF ARTS, LONDON.

January 28.—W. F. COOKE, Esq., in the Chair.

The first paper read was by Mr. Claudet, on "*some principles and practical facts in the art of Photography*," and contained a series of very interesting scientific researches, and communicated several important discoveries in this new and curious field of research. It was a sequel to a communication read by Mr. Nott on a previous evening, in which he had endeavoured to establish that the rays which make the photographic picture are different from those which produce light, and this he thought he had proved by means of pictures formed with a polarized ray reflected from parallel plates. Mr. Claudet contends that the rays of light are the agent. He had made many experiments on forming pictures by reflection, but had not been able to discover any essential difference betwixt them and such as are formed by the direct ray.—His next series of experiments regarded the photographic qualities of light of different colours; blue proved to be the most powerful photographic agent, yellow the weakest. One of the most beautiful experiments by which this was proved, consisted in throwing the prismatic spectrum on paper and on the silver plate, the colours being marked on the paper and the effect remaining on the photographic plate—he thus showed that the photographic prism presents effects very different from the apparent intensity of the prismatic spectra. A remarkable specimen was shown of a silver plate, on which the rays of light had brought out a powerful picture without the action of mercury.—Another series of experiments made was on the photographic action of the rays of the moon, which had formed a powerful picture by five minutes exposure; he hoped to be able to obtain a very accurate Daguerréotype of the moon's surface, drawn by herself, on a silver plate.

Considerable discussion followed, and the announcement in the paper as received with much approbation.

"*On a New Code of Signals and the Construction of the Signal Lamps.*"—By Mr. RETTIE, and illustrated by models and experiments. By the simple use of a pair of slides attached to an ordinary lantern, a combination of signals is effected, by which the loss of life and property by the collision of steam boats and sailing vessels, might be simply and cheaply avoided.

February 4.—WILLIAM POLE, Esq., F.R.S., Vice-President in the Chair.

The following papers were read:—

The first communication was "*On the Theory of the Construction of the Portland Vase.*" By MISS P. ENSELL.—Miss Ensell considers the Portland Vase to have been constructed in the following manner. A jar of blue glass was formed in the usual way by the glass blower, and its whole surface roughened—it was then enclosed in a mould similar to those used for the formation of alabaster relievos; the jar and mould were then exposed to the action of one of the petrifying springs of Italy, and thus a clear transparent substance was deposited on the vase, in such proportions as to form the figures in that beautifully white semi-transparent material, which is exhibited in the Portland Vase. She then gave various details for the practical carrying out of the operation, and suggested the propriety of undertaking a series of experiments, with a view to constructing vases of a similar description.

Mr. Doubleday, the gentleman who was charged with the restoration of the Portland Vase, and which is now under his care, having examined its structure most minutely, proceeded to give the following account of the manner in which it had been formed. The base is of blue glass and has been made in the usual manner by the glass-blower, the white figures are also of glass and perfectly united with the base. The blue jar having been formed, was dipped into a pot of white metal, and so the lower part of it became entirely covered with a uniform coating of white glass. The material to work upon, which is thus described is in all respects similar to the cameo, and has been operated on in the same manner. With some talent and considerable artistic skill, by a process like that of gem engraving or cameo cutting, the white glass has been cut away in different forms, and various thicknesses by the artist; he considered that not less than 3 or 4 years of continuous labour would be required in order to produce such a work of art.—Several other gentlemen then joined in the discussion, the result of which was to establish the fact that we possess in this country both materials, mechanical means, and artists capable of executing similar works to the Portland Vase, and that those works, if executed, would necessarily, from the length of time and skill required to execute them be the most rare and most costly that art can produce.

"*On a New Theory of the Formation of Meteoric Stones.*" By ARTHUR WALL, Esq. He considered they were derived from subterranean origin; he showed by analysis that abundance of materials and means are presented for the formation of those meteors in the bowels of the earth, and their descent from the atmosphere without going into the planetary spheres to seek for their cause.

February 18.—E. SPEER, Esq. in the Chair.

The discussion on the *Portland Vase* was resumed.

Mr. Doubleday, of the British Museum, who has repaired the Portland Vase in a manner so admirable that the fractures are scarcely visible, presented a number of specimens of ancient manufactures in glass, illustrative of the theory which he deduced on the true principles of its construction. Mr. Apsley Pellatt, who was present, exhibited to the society, through Mr. Blashfield, a very beautiful model of the Vase, it being one of the original and most perfect copies made by Wedgwood. He explained fully to the meeting, as a practical manufacturer of glass, the exact process by which he conceived that that vase was originally formed. He explained how such objects of art might be constructed at the present day, and the difficulties which stood in the way of their construction. Mr. Christie, of the Vauxhall Glass-works, explained another mode in which the two colours of glasses might have been originally united.

"*On Railway Locomotion, with reference to the effects of Centrifugal and Centripetal Forces.*" By Mr. C. H. GREENHOW. He proposes for the purpose of increasing the safety of railway trains to suspend the bodies of the carriages upon an horizontal axis, in such a manner that the centre of gravity being equal, shall equipoise the centrifugal force. He gives to the rails the form of a hollow circular tube, and to the flanges of the wheels a corresponding form, by which he conceives that the forces tending to throw the tram off the line would be counteracted. The wheels also are so constructed that the spokes form a straight line passing between the rails and the centre of gravity of the body; all these arrangements are designed by him to give increased safety and stability to the railway trains. A long discussion ensued, in which many practical engineers and scientific gentlemen took an active part. It was maintained by some of them that no increased stability was given by permitting the centre of gravity to oscillate, but on the contrary it would thereby be considerably weakened, and; that the wheels would not adjust themselves to the partial variations and irregularities in the condition of the railway; that there would be attrition between the rails and the flanges of the wheels and that of the circular form of rail being of cast iron would not be safe. To these allegations Mr. Greenhow gave various replies, and the discussion was prolonged to a late hour when it was adjourned.

AMERICAN PATENTS.

(From the American *Franklin Journal.*)

"*Improvement in the Coupling and Stuffing Box for shafts, specially intended for submerged propellers for Ships.*" By R. F. LOPER, Philadelphia. Oct. 9, 1845.

The outer tube of the stuffing box, instead of being permanent, is tapped into a metallic casing surrounding it so as to admit of screwing it over the lapped or other joint of the shaft, so that when this tube is drawn in, the two shafts can be separated, and if desired, the propeller drawn out of the water, and when screwed out, passes over and prevents the two shafts from being separated.

"*Improvement in the Current Water Wheel.*" By J. D. ROBINSON, Illinois. Oct. 24, 1845.

The buckets are each composed of several narrow strips attached to chains binged to a cylinder, so formed as to permit them to fold in one direction, but not to go beyond a line radiating from the centre of the cylinder to which they are jointed—when acted upon by the current, these buckets are thrown open, but so soon as they begin to make back water they fold on the periphery of the cylinder, and prevent undue resistance.

"*Improvements in Tide Mills.*" By JOHN GERARD ROSS, New York. Nov. 9, 1845.

The wheel is placed in a race, at one end of which there is a tide gate hinged to a wall beyond the end of the race and shutting against either side of the race; and at the other end of the race there are two current gates, one termed the "inner current gate," and the other the "outer current gate;" these are binged to the ends of the race way wall, and shut against a pier placed beyond the end, and in a line with the middle of the width of the race way. The current in passing along opens the "current gate," and after acting on the wheel, passes out through the "outer current gate," and on the return tide the pressure of water closes this "outer current gate," which causes the current to pass around to that side of the tide gate opposite to that at which it entered on the rise of the tide, throws it against the opposite side of the race-way, acts on the same side of the wheel as on the rise of the tide, and passes out through the "inner current gate." The dam walls are formed with pits, open at the sides for the free ingress and egress of the water to act on floating caissons which sustain the wheel and always keep it at the required elevation. The shaft of the wheel (or wheels) is connected with the frame-work of the mill by bars radiating from the axis of a cog wheel, into which work the cogs of the master wheel.

"*Improvements in the Means of Removing Mud, Sand Bars, &c. from the Beds of Rivers, &c.*" By DENNIS VERMILION, Washington, D. C. Nov. 9, 1845.

A mass of logs are put together in the form of a boat, to be moved down by the current, tide, or otherwise, and which from its great weight and strength will acquire great momentum. Iron breakers sharpened at the lower end, pass obliquely through apertures in the mass, and extend down to the depth required to act on the obstruction to be removed. At the stern there is suspended a drag rake, connected with the boat by means of two arms that slide freely in apertures in the ends of a cylinder which is hung on appropriate journals; and for the purpose of raising this rake, cords extend from it to a windlass on the boat. The operation of the apparatus is this—the boat being put in motion by the current, or otherwise, is directed towards the sand bank, or other obstruction, and the breakers and rake having been set to the required depth, the breakers cut up and loosen the sand, mud, &c., which is then raked into deeper water.

"*Improvements in Horizontal Wind Mills.*" By DANIEL DENNET. Nov. 13, 1845.

The wing or vanes of this are jointed to radial arms, and are suspended by cords to vibrating levers that pass through, and are jointed to, the shaft above the arms to which the wings or vanes are jointed, so that by this arrangement the moment one vane begins to make "back wind," (as it is termed,) it is blown down, and by its connection with the one on the opposite side of the shaft draws it up to catch the wind.

"*Improvements in Water Wheels.*" By JOHN L. SMITH. Dec. 10, 1845.

Two of these wheels are put on a horizontal shaft, one on each side of the trunk or tunnel through which the water is applied to the wheel, the face towards the tunnel being open for that purpose. The apertures or issues for the water extend from the shaft to the outer rim, which is scolloped for that purpose, and are formed by the forward edge of one bucket, and the back edge of the other, these being placed diagonally for this purpose. And to the back edge of each of these buckets there is a flanch radial in its length, and parallel with the shaft in the direction of its width, which extends to the inner face of the wheel, or to the floor.

"*Improvements in the mode of preparing, applying, and using certain fluxes for the reduction of Ores in the Blast Furnace.*" By JONAS TOWERS, Madison, Lake county, Ohio, Dec. 7, 1845.

What I claim as my invention, and desire to secure by letters patent, is the application of those earths or minerals which are dissoluble or diffusible with water, and have an adhesive nature, and can be made into a paste, pap, or grout, with the above or other liquids, and can be applied as other fluxes for the reduction of ores or minerals in the blast or other furnaces. I claim the application of the above preparation, as herein described, to other minerals as well as iron, which have a similar objectional tendency, while smelting, that is found with iron. I do not claim any special right to the use of the above fluxes in a dry or natural state; it is only after they have been mixed or diffused with water or other liquids, and formed into a paste, pap, or grout, and applied as a coating or adhering substance, as herein described, that I claim as my invention, or discovery, and desire to secure by letters patent.

"*Opening and closing Waste Water Gates.*" By ROBERT ROBINSON.

The gate is provided with a chain which passes over a roller, and is attached to one end of a lever, the other end having a box suspended to it. When the water rises too high, it passes over a dam, and fills the box, which, by its preponderance, sinks, and opens the gate; and the box being provided with small holes, after the water has ceased to flow over the dam, it runs out of the box, and thus gives the preponderance to the gate, which is then closed by the pressure of the water.

"*Hydraulic Gate, for Locks, Docks, &c.*" By GEO. HEATH. Antedated July 3, 1841.

This improvement consists in using for the gate, singly or in two parts, the segment of a cylinder for the front of the gate, with the radius which cuts the centre line of the arch of the segment lying horizontally, and with the arch next the water which is to be passed. This front of the gate rests for its support against the pressure of the water, on gudgeons at the centre of the cylinders, which are connected with the front, either by arms, or by the sector of a circle, at the two ends of the segment.

For a composition of matter for "*lubricating the rubbing surfaces of machinery.*"—Increase S. Hill, and Joseph Dixon, the former of Boston, and the latter of Taunton, Massachusetts, January 31, 1845.

The patentees say, "our composition consists mostly of zinc, (which as is well known belongs to the class of cheaper metals) hardened by being compounded with what we denominate a *hardening composition.* This latter composition is formed of the following metal, mixed in a state of fusion in the proportions hereinafter specified, viz., 15 parts of tin to 35 parts of copper. This composition in a state of fusion is to be mixed with molten zinc and tin, (although tin is not absolutely essential) in the proportion of the two parts of the said hardening composition, of 19 parts of zinc, and from three to five parts of tin, according to the peculiar purpose for which the composition is to be used, the tin specified to be added last, having the tendency to render the compound when cold more or less ductile, according to the quantity of the same incorporated therewith. The metal formed without the addition of the last named proportion of tin, when broken, will have the appearance of cast steel of coarse quality, but the addition of tin will make it stronger and cause it to be finer in grain until four parts of the same will be added, when the appearance of the metal on its being broken, will be like that of fine cast steel and more closely resemble the same than any other metal. The great strength of the composition combined with a certain degree of softness which it possesses, renders it highly useful in the construction of bearings for rubbing surfaces of machinery, as it is capable of resisting for a great length of time, the effects of wear and attrition. The large proportion of zinc used in forming the compound renders its use in the mechanical arts, much less expensive than the metal ordinarily employed for these purposes, the cost being much less than any other composition in which copper and tin are the principal metals."

REGISTER OF NEW PATENTS.

If additional information be required respecting any patent, it may be obtained at the office of this Journal.

ATMOSPHERIC RAILWAYS.

WILLIAM SYKES WARD, of Leeds, gentleman, for "*Improvements in exhausting air from tubes or vessels for the purpose of working atmospheric railways, and for other purposes.*"—Granted June 25; Enrolled December 25, 1845.

The object of these improvements relates to the arranging and working of the valves of air-pumps for the purpose of exhausting the air from the traction-tubes of atmospheric railways, and also for the purpose of exhausting air from any vessels or tubes upon a large scale. In using air-pumps as hitherto practised for working atmospheric railways, power is lost in opening the inlet and outlet valves, by the action of the air entering into, and expelled from the cylinder of the pump, and the violence with which such valves close is objectionable.

The inventor's mode of constructing air-pumps is such, that the power required for opening and shutting the valves is supplied by gearing, or mechanical movements, from the engine, or other source of power by which the air-pump is actuated, so that the inlet valves are opened and shut alternately, almost immediately after the commencement of the stroke of the piston of the pump, and the outlet valves are respectively closed, or pushed home, at the end or conclusion of the stroke of the piston. The gearing afterwards releases the valve, which is retained on its seat by the pressure of the external air, until the air within the cylinder of the pump becomes nearly of the same density as the external air, when the valve (if the lower outlet) falls by its own weight, or (if the upper outlet) is raised by a counterpoise of greater weight than the valve, or by a spring, thus moving rather in advance, or as though in anticipation of the current of expelled air, and affording a free passage for it.

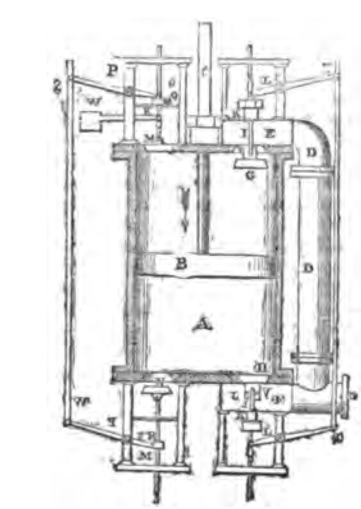


Fig. 1, A, represents the cylinder of the pump, B, the piston, C, the piston-rod, D, D, D, pipes communicating between the main, or vessel to be exhausted, and the upper inlet valve-box, E, and the lower inlet valve-box, F. G, represents the upper inlet valve, and H, the lower inlet valve, which valves, G, and H, are attached to the rods, I, and I, at V, and V, by joints, allowing a slight motion, so that the valves may the better close on their respective seats. The rods I, move air tight, in stuffing-boxes K, in guides, by levers L, and connected by the rod T, part of which only is shown. M represents the upper, and N the lower outlet valve, attached to the rods O, and O, moving in guides, and which valves, M and N, may be respectively closed by the levers P, fixed and acting upon the tappets Q, so as to close the valves M and N alternately, but not to open them. The upper valve M is counterpoised, and somewhat overweighted by the lever R R, and the weight S. The lower valve N opens by its own gravity, when not closed by the lower lever P, or supported by the pressure of the atmosphere against a partial vacuum in the lower part of the cylinder A. The levers P are connected with an excentric by the rod W, part of which only is shown.

The mode of action is as follows:—Suppose the pump has already exhausted the main, or vessel connected therewith, to half vacuum, and is making the down stroke; the air from the main, therefore, enters at the upper valve, which was opened by the lever L, immediately after the commencement of the down stroke, and the lower valve H, was closed at the same time. The upper outlet valve M, was closed simultaneously with the conclusion of the ascending stroke, and remains closed during the down stroke; and, at the same time, the end, P *a*, of the lower lever P, released the stud, or tappet Q, leaving the lower valve N, at liberty to open by its gravity; but the air in the cylinder of the pump having had, at the commencement of the stroke, only half the density of the external air, the valve N, will have been supported until the piston descended to about the middle of the stroke. The gravity of the valve N, will then overcome the cohesion of its surface, and of the valve-seat, and open, leaving a free passage for the air to be expelled from the bottom of the cylinder. When the piston approaches the bottom of the cylinder, the valve N, will begin to be raised by the lower lever P, the motion of the piston, from its connexion with the crank of the engine actuating or driving it, will have become slower, so that the aperture will, nevertheless, be adequate for the expulsion of the air; but, at the turn of the stroke, the last-mentioned lever P, will close the valve N, quietly, so as to avoid any detrimental concussion consequent on the change of the stroke. The upper inlet valve G, will be closed, and the lower inlet valve H, will be opened. The upper outlet valve M, will be left free, but, as before explained, will remain closed, until the density of the air above and below it are nearly equal, when it will be raised by the counterpoise or weight S.

Another part of the improvements consists in the combination of large vessels with air-pumps, so that such vessels, having been previously exhausted, shall assist the pumps in the exhaustion of the traction-tube. The cylinder of the pump must be of such dimensions, as to be capable of restoring the exhaustion of the reservoirs in the interval between the running of the trains on the section of railroad it is required to work. And the steam engine is to be of such power as to work the pump, and restore such exhaustion of the reservoirs with facility, in the before-stated period, after the first reservoir has been exhausted, but such exhaustion need not be continued to a very high gauge; for example, the first reservoir may be exhausted until a barometer gauge attached thereto shows the height of about fifteen inches of mercury; by a change of position of the cock Q, the second reservoir may then be exhausted to about twenty inches of its gauge, and lastly, by a further change of the cock, the third reservoir may be exhausted to about twenty-five inches of its gauge.

Another part of the improvements consists in the construction of the pistons of large air-pumps, by making the packing of the pistons of leather cut into bands, of the breadth of about one-sixth part of the diameter of the cylinder of the pump. Such bands are united by sewing, and also with the well-known cement of isinglass or fish-glue dissolved in weak spirit, or are united by other suitable means, so as to form a continuous circle of about the same diameter as the pump cylinder, but considerably conical, so as to facilitate the bending hereinafter mentioned. The bands of leather, after being softened by water and placed upon a block of similar size to the piston, are then bent and contracted so that about one-third part of the breadth may fit the cylinder and the other two-third parts may be attached to the piston, and secured by plates of metal screwed to the main part of the piston.

The claim is for so arranging apparatus or gearing with the valves of air-pumps, as to close the outlet valves but not to open them, the gearing leaving such valves at liberty to open when relieved from the pressure of the air. Secondly, the so combining vessels or reservoirs with air-pumps in working atmospheric railways that the air may be pumped from the traction-tubes of atmospheric railways into partially exhausted vessels or reservoirs, and, when desired, the pressure of the air passing from such traction-tubes into such partially exhausted vessels or reservoirs may be used for giving motion to air-pumps. And thirdly, the mode of packing pistons of air-pumps as herein described.

William Palmer, of Clerkenwell, in the county of Middlesex, manufacturer, for "*Improvements in working atmospheric railways, and in lubricating railway and other machinery.*"—Granted June 5; Enrolled December 5, 1845.

This invention consists in applying tallow, oil, or other fatty matter, or of oil prepared in the form of soap, insoluble in water, to line the tubes and to aid atmospheric railways; and the said invention also consists in applying such materials to the lubricating railway and other machinery. Any quantity of the tallow-oil is taken and heated in a copper or boiler to the point of boiling, or nearly so, and then litharge is stirred in so long as the same is taken up by the tallow-oil, and until the litharge falls to the bottom and is not taken up by the tallow-oil; after stirring for half an hour from the time the last quantity of litharge has been introduced, the melted matter is removed into casks or other suitable receptacles. By this means a soap insoluble in water, will be produced, suitable for the purposes of the invention.

The claim is for the application of tallow-oil or other fatty matters, or oils prepared in the form of soap insoluble in water, by means of litharge or other metalline matters, to line the interior surfaces of the traction-pipes of atmospheric railways, and also for lubricating machinery as herein described.

Joseph Cliff, of Wortley, Yorkshire, fire-brick manufacturer, for "*Improvements in the manufacture of alum, and of aluminous compounds, from a substance not hitherto used for that purpose, and in the production of an improved fire-clay from the residuum thereof.*"—Granted June 5; Enrolled Dec. 5, 1845.

This invention relates to fire-clays containing a great quantity of alumina, especially the "Wortley fire-clay." For extracting the whole or the greater part of the alumina, and converting it into alum and aluminous compounds, and in using the purified clay, either alone or combined with other fire-clay, for making fire-bricks, glass-house pots, crucibles, gas-retorts, and similar articles. Any fire-clay containing alumina in excess, is first ground, then calcined, and afterwards submitted to the action of sulphuric, nitric, muriatic, or other acid, diluted with water. The mass being lixiviated with water, the alumina is obtained in solution, and this solution is freed from iron by the employment of prussiate of potash, gallic acid, sulphuretted hydrogen, or some other suitable agent, the solution is then evaporated by itself, to get the sulphate, nitrate, or muriate of alumina, according to the acid used; or the sulphate or muriate of potash, soda or ammonia is mixed with the solution, and evaporated or crystallised to obtain the alum salts, and then, by roaching, the alum of commerce is formed. After he whole or greater part of the alumina has been extracted, as above described, the purified and residuary earth may be employed, alone, or combined with other clay, in the manufacture of fire-bricks, glass-house pots, crucibles, gas retorts, and similar articles.

John Hopkins, of Brand-street, Greenwich, in the county of Kent, surveyor, for "*certain improvements in rails and trams for railroads and tramways.*"—Granted July 3, 1845; Enrolled Jan. 3, 1846.

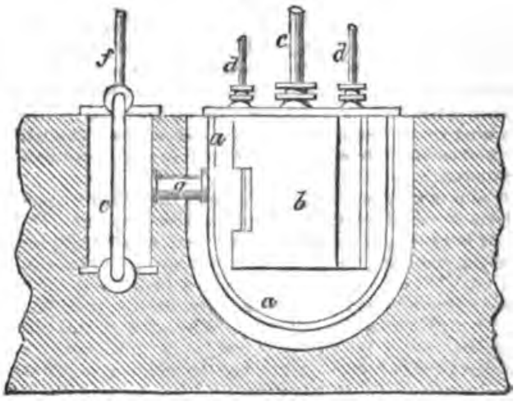
The object of this invention is to employ rails, trams, or continuous surfaces of wood, upon which the wheels of engines and carriages may travel as on the ordinary rails or trams, consisting of a piece of timber, placed longitudinally and bolted between two cheeks of iron.

HOT AIR ENGINE.

Isham Baggs, of Great Percy Street, Claremont Square, engineer, for "*Improvements in obtaining motive power by air.*"—Granted June 26, 1845; Enrolled January 26, 1846.

The first part of this invention is to cause condensed air to pass from a vacuum placed within a flue, and surrounded by fire, to the cylinder of an engine, so as to give motion to the piston of the same by its elastic and expansive power, the condensed air being supplied from time to time by means of a double acting pump. The heated air after having worked the engine is conducted by means of a pipe to the furnace or fire, for the purpose of increasing combustion.

The apparatus consists of a cylinder, constructed somewhat in the ordinary manner, having induction and eduction ports with suitable valves. This cylinder is placed vertically within a closed receiver, or strong iron vessel, fixed in such manner that it is surrounded by a flue, and can be heated by a fire for the purpose of expanding the air within it, which after having worked the piston of the engine passes through the eduction port, and is conducted to the fire if desired. The piston rod is attached in the ordinary manner to the crank, and upon the same shaft is a second crank for working the force, or air-pump, which at every stroke forces into the receiver a quantity of air equal to that expended in moving the piston. The specification is accompanied with three or four sheets of diagrams, showing sections of the cylinders &c., which would be too elaborate to give in detail. The annexed rough sketch shows the position of the working cylinder, receiver, and air pump, which we have no doubt the reader will understand by the following description—*a a* is the



receiver or reservoir, fixed in brickwork and surrounded with a flue proceeding from the furnace; *b* is the cylinder of the engine placed within the same; *c* is the piston rod connected with the crank-shaft in the usual manner by a connecting rod; *d d* are the valve rods worked by means of excentrics; *e* is a double-acting air pump for forcing air into the receiver *a*; *f* is the piston rod connected with a second crank formed on the crank-shaft, which latter crank is placed about 140 degrees in advance of the other crank, in order that the resistance may not be greatest when the power is least. In starting this engine atmospheric air is to be forced into the receiver equal to 4 atmospheres, by means of hand pumps or otherwise; the fire is then to be lighted, which will have the effect of expanding the air which is then admitted into the cylinder; when motion will be given to the piston, and crank shafts, (not shown in the diagram,) and by means of the second crank such motion will be imparted to the piston rod *f*, of the air-pump *e*, which is provided with two induction and two eduction valves, and intended to force into the receiver *a* just as much common atmospheric air as has been expended in giving motion to the piston in the cylinder *b*, the slide valves of which are worked expansively; *g* is the eduction pipe of the air-pump, and is connected to the receiver, the induction pipe being open to the atmosphere, by closing which the engine will be stopped, in consequence of the supply of air being cut off.

HIGHTON'S SAFETY RAILWAY CHAIRS.

The peculiarity in the fastening of the rails by means of the Safety Chair and Key Wedge, consists in making the side of the chair next to the key with a concave instead of a plane surface, and using a peculiarly shaped cast iron wedge, in connection with the key. After the timber is inserted into the chair, a safety wedge is to be driven into the key near to the side of the chair as shown in the drawing. This forces the key into the concavity of the chair producing perfect contact between the key and the interior of the chair. The key being thus made larger in the middle than at the ends, is unable to leave the chair until forcibly driven out by the hammer. The wedge is prevented from splitting the key by the combined action of the two projections cast in the sides of the wedge at its lower end, and the shape of the interior side of the chair. When the wedge is being driven into its place, these projections cut all the fibres of the wood across as the wedge enters the key; and as many as five or six wedges may if required, be driven into the key without splitting or injuring it in the least degree.

The end attained by this description of fastening for the rails of a railway, consists in the impossibility of the keys shaking out by the combined action of the shrinkage of the keys in dry weather, and the passage of the trains: an advantage of the greatest importance on all lines of railway using chairs.

The accompanying engraving shows that it is impossible for the key to shake out until it has shrunk at least a quarter of an inch; this a well-seasoned key will never do: but should the shrinkage in very dry weather amount to anything near this, the driving in of an additional safety wedge will make the key as fast as ever; and it will then become more perfect than at first, as its fibres will be more closely compressed, and consequently, less subject to alteration in size by change of weather. The weight of each safety-wedge is less than 2 oz.; and the inventors state that more iron is saved in the concavity of the chair, than is sufficient to make a safety-wedge.

Fig. 1 Fig. 2

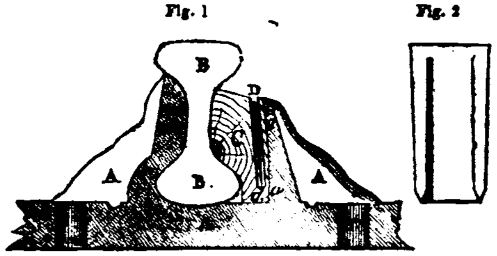


Fig. 1 is a vertical section of the chair, showing its key and wedge. Fig. 2 is a flat or front view of the fastening wedge. A is the chair. B the rail. C a wooden key driven in a horizontal direction between the rail and chair, and transversely across the chair. D is the metal wedge driven vertically downwards into the, key with its width laid in the direction of the length of the key, forcing a portion of the key against or into the hollow side *d d* of the arm *a a* of the chair, the key is thus secured between the rail and its chair.

We understand that this improvement has been adopted with success on three miles of the Taff Vale Railway, and after being in use for three months, and upwards of 1,200 trains passing over the line not a single key was removed.

RAILWAY PROCEEDINGS.

We propose to give under this head selections from the decisions of the sub-committee on the standing orders. It must be understood that the decisions are not always final, as the petitioners may go before another committee on the standing orders, who may if they see fit, recommend the House to waive the conformance to the standing orders.

House of Lords, Feb. 6.

"Resolved, that it is the opinion of this committee that such portion of the standing order No. 224 as requires a deposit of one-tenth of the amount subscribed, should be suspended with respect to all such railway bills as shall commence in the House of Lords during the present session.

"That no such railway bills shall be read a first time in this house unless a deposit of one twentieth part of the amount subscribed should have been paid on or before the 6th of February.

"That no such railway bills shall be read a third time until a further deposit of one-twentieth part of the amount subscribed shall have been in like manner paid.

"Resolved also, that it is the opinion of this committee that this house should not receive any petition for a railway bill after Monday, the 23rd of February."

House of Lords, Feb. 13.

The House of Lords resolved that the standing orders be amended as follows:—

That it is the opinion of this committee that the standing orders of this house with regard to railway bills, should as respects railway bills commenced in this house during the present session, be altered in the following particulars.

That standing order No. 219 be altered in the following particulars, viz., that on the bill being reported to the house from the committee on the bill, or at any time previously, on the petition of the parties to such bill, or any of them, the bill shall be referred to the Standing Orders Committee, which shall inquire whether standing orders, the compliance with which is directed to be proved before or reported by the Standing Order Committee previously to the third reading of the bill, have been complied with; and the committee shall report on the matters referred to them in the same manner as they are directed to report on other matters referred to them by the standing orders.

That five clear days' notice be given of such meeting of the committee, and that it be proved to the satisfaction of the committee, that the standing orders had been complied with five clear days before such meeting of the committee.

That the Standing Orders Committee shall not meet to consider the compliance with such of the standing orders as are directed to be proved before them until after the expiration of seven clear days from the presentation of the petition if the bill relate to England, or until after the expiration of 10 clear days if the bill relate to Scotland or Ireland.

That every petition complaining of a non-compliance with such of the standing orders as are directed to be proved before the Standing Orders Committee subsequently to the first reading of the bills, shall be presented three clear days before the meeting of the committee to consider such standing orders.

That standing order No. 220 be altered in the following particulars, viz., that the service of every application required to be made to the owners or reputed owners, lessees or reputed lessees, and occupiers, by the fourth paragraph of the said standing order, may, unless a petition complaining of the want of due service of such application shall have been referred to the Standing Orders Committee, be proved by the evidence of the agent or solicitor for the bill, stating that he gave directions for the service of such application in the manner and within the time required by the standing orders, and that he believes that such application was so served; but in case the Standing Orders Committee shall not be satisfied with the evidence of the agent or solicitor, the service of such application shall be proved in the usual manner.

That no bill commencing in this house and empowering any company already constituted by act of Parliament to execute any work other than that for which it was originally established, shall be read a third time, unless the Committee on Standing Orders shall have especially reported that the requisitions contained in paragraph No. 5 of such order have been complied with.

That standing order No. 224 be altered in the following particulars, viz., that as respects all railway bills which shall commence in this house during the present session of parliament, it shall be proved to the satisfaction of the Standing Orders Committee that a sum equal to 1-20th part of the amount subscribed has been deposited, in the manner required by the said standing order, on or before the 6th day of February inst.; and it shall likewise be proved to the satisfaction of the said committee, before the third reading of such bill, that a further sum, equal to 1-20th part of the amount subscribed, has been deposited in like manner.

That standing order No. 225 be altered in the following particulars, viz., that it shall be sufficient if the proof required to be given by the last mentioned standing order be adduced before the Standing Orders Committee at any time previous to the third reading of the bill.

That all the standing orders applicable to railway bills, except such of them or such part of them as are altered by or are inconsistent with the aforesaid standing order, shall apply to the railway bills commenced in this house during the present session of Parliament, and to the proceedings on such bills.

House of Commons.

First Report, Feb. 5.

The select committee appointed to consider the mode in which the house shall deal with the railway bills proposed to be submitted to the House during the present session, and who are empowered to report from time to time to the House, have considered the matters referred to them, and agreed to the following report:—

That for the purpose of facilitating the dispatch of railway business during the present session, it is expedient that a portion of the railway bills should commence in the House of Lords.

That with respect to any railway bills which, in pursuance of these resolutions, shall commence in the House of Lords during this session, this House will not insist on their privilege with regard to the clauses fixing and regulating rates and tolls in such bills.

That with a view of affording early and increased means of employment in Ireland, it is expedient to give facilities for the early consideration of Irish railway bills.

That, for the attainment of this object, it is expedient that all Irish railway bills should, in the present session, commence in the House of Lords.

That it is expedient that all bills which compete with or ought to be considered in connexion with any bills, the promoters of which shall prove themselves entitled to the privileges agreed to be granted in certain cases by the resolutions of this House of the 7th July last, shall commence in the House of Lords.

That the parties promoting railway bills which, by the above resolutions, are to commence in the House of Lords, may (notwithstanding any proceeding respecting such bills in the House of Lords) prove before the committee on petitions of the House of Commons that they have complied with the standing orders of this House, and the report of such committee shall be ordered to lie on the table. If the committee should report that the standing orders have not been complied with, their report shall be referred to the committee on standing orders, whose report shall be ordered to lie on the table.

That when a railway bill shall have commenced in the House of Lords, and shall be sent down to the House of Commons from the House of Lords it shall be read the first time in the House of Commons, and shall then be referred to the committee on petitions, to ascertain whether the railway bill so sent down is substantially in accordance with the standing orders, as determined by the House of Commons.

SECOND REPORT, FEB. 10, 1846.

1. That a committee of five members be appointed, to be called the Classification Committee of Railway Bills, and that three be the quorum of such committee.
2. That copies of all petitions for railway bills presented to the House be laid before the said committee.
3. That the committee of classification shall inquire and report what railway bills compete with, or ought to be considered in connexion with any railway bills, the promoters of which shall have proved themselves entitled to the privilege agreed to be granted in certain cases by the resolutions of this House of the 7th of July last.
4. That the committee of classification shall form into groups all other railway bills which, in their opinion, it would be expedient to submit to the same committee.
5. That as soon as the committee of classification shall have determined what railway bills are to be grouped together, they shall report the same to the House, and all petitions against any of the said bills shall be presented to the House three clear days before the meeting of the committee thereon.
6. That no railway bill be read a first time later than the next day but one after the report of the committee on petitions or of the standing order committee on such bill, as the case may be, shall have been laid on the table, except by special order of the House.
7. That there be not more than seven clear days between the first reading of any railway bill and the second reading thereof, except by special order of the House.
8. That the breviate of every railway bill shall be laid on the table of the House, and be printed and delivered one clear day before the second reading.
9. That such railway bills as shall have been read a first time before the House shall agree to these resolutions, shall be read a second time within seven clear days thereafter.
10. That such of the standing orders as relate to the composition of the committees on private bills, and the orders consequent thereon, be suspended so far as regards railway bills pending in the course of the present session.
11. That committees on railway bills during the present session of Parliament shall be composed of a chairman and four members, to be appointed by the committee of selection.
12. That each member of a committee on a railway bill or bills, shall, before he be entitled to attend and vote on such committee, sign a declaration that his constituents have no local interest, and that he himself has no personal interest for or against any bill referred to him; and no such committee shall proceed to business until the whole of the members thereof shall have signed such declaration.
13. That the promoters of a railway bill shall be prepared to go into the committee on the bill on such day as the committee of selection shall, subject to the order that there be seven clear days between the second reading of every private bill and the sitting of the committee thereupon, think proper to appoint, provided that the classification committee shall have reported on such bill.
14. That the committee of selection shall give each member not less than 14 days' notice of the week in which it will be necessary for him to be in attendance, for the purpose of serving, if required, on a railway bill committee.
15. That the committee of selection shall give each member a sufficient notice of his appointment as a member of a committee on a railway bill, and shall transmit to him a copy of the 12th resolution, and a blank form of the declaration therein required, with a request that he will forthwith return it to them properly filled up and signed.
16. That if the committee of selection shall not within due time receive from each such member the aforesaid declaration, or an excuse which they shall deem sufficient, they shall report to the House the name of such defaulting member.
17. That the committee of selection shall have the power of substituting at any time before the first meeting of a committee, another member for a member whom they shall deem it proper to excuse from serving on that committee.
18. That power be given to the committee of selection to send for persons, papers and records, in the execution of the duties imposed on them by the foregoing resolutions.
19. That no member of a committee shall absent himself from his duties on such committee, unless in the case of sickness, or by leave of the House.
20. That all questions before committees on railway groups or bills shall be decided by a majority of voices, including the voice of the chairman; and that whenever the voices shall be equal, the chairman shall have a second or casting vote.
21. That if the chairman shall be absent from the committee the member next in rotation on the list (who shall be present) shall act as chairman.
22. That committees shall be allowed to proceed so long as three members shall be present, but not with a less number, unless by special leave of the House.
23. That if on any day within one hour after the time appointed for the meeting of a committee three members shall not be present, the committee shall be adjourned to the same hour on the next day on which the House shall sit, which had been fixed for that day.
24. That in the case of a member not being present within one hour after the time appointed for the meeting of the committee, or of any member absenting himself from his duties on such committee, such member shall be reported to the House at its next sitting.
25. That each committee shall be appointed to meet on each day of its sitting, not later than 12 o'clock, unless by the regular vote of the committee.
26. That committees on railway bills have leave to sit in the present session, notwithstanding any adjournment of the House, if the committees shall so think fit.
27. That every committee on a railway bill shall fix the tolls, and shall determine the maximum rates of charge for the conveyance of passengers (with a due amount of luggage) and of goods on such railway, and such rates of charge shall include the tolls, and the costs of locomotive power, and every other expense connected with the conveyance of passengers (with a due amount of luggage) and of goods upon such railway; but if the committee shall not deem it expedient to determine such maximum rates of charge, a special report, explanatory of the grounds of their omitting so to do, shall be made to the House, which special report shall accompany the report of the bill.

THIRD REPORT, FEB. 17.

The number of petitions for railway bills, which have been presented this session, have been stated by your committee to amount to 562, viz.:—

For railways in England and Wales	395
„ Scotland	120
„ Ireland	47

The above numbers include petitions for amalgamation bills, and in some cases there are more petitions than one for the same scheme. After the deduction to be made on this account, the number of distinct railway shemes appears to be—

For England	351
Scotland	83
Ireland	47
	481

As, however, many of these schemes may fail, from non-compliance with the standing orders, the number of bills presented to Parliament may possibly fall considerably short of this amount, and your committee are of opinion that it will not be necessary or expedient in the present session of Parliament to refer mere projects to committees, as was done, owing to peculiar circumstances, in the last session.

From a statement prepared by the officers of the Board of Trade, it would appear, that if the same principle of grouping which was adopted last year should be followed in the present session, the railway schemes in England and Wales might be formed into 51 groups, and those for Scotland into 10; about 61 select committees would therefore be required.

As the house has already ordered, that all Irish railway bills, and a certain limited class of English bills, (the latter of which are included in the foregoing statement), should commence in the House of Lords, it is impossible to say how many of these may be sent down to the House of Commons. The number of groups into which railway schemes for the United Kingdom were divided last year was 52; but, owing to various circumstances, only 45 committees appear to have actually sat.

The necessity of considering so great a number of railway bills, in addition to other private bills, may certainly be expected to produce an unusual and inconvenient pressure upon the time of members of the house; but your committee trust, that as committees on railway bills may in this session begin to sit at an earlier period than in the last, it will not be found impracticable to constitute the requisite number of committees during the progress of the session.

Under these circumstances, your committee have not deemed it advisable to recommend to the house to make any selection from, or to place any limitation on, the number of railway schemes to be submitted to the consideration of Parliament during the present session.

As your committee, however, believe that much of the time of the select committees on railway bills is consumed, with little public benefit, in minute and detailed inquiries into the amount of traffic and the probable profit to the projectors, your committee are of opinion that the standing orders on these points should be altered, and that it should no longer be obligatory on committees on railway bills to make special reports on them.

At the same time, your committee have no wish to fetter the discretion of the select committees to make such inquiries as they may judge proper with regard to population, and to the extent of accommodation that would be afforded to the public, where they consider such information to be required.

Your committee beg further to suggest, that power be given to select committees to refer the consideration of any unopposed railway bill included in the group referred to them to the chairman of Ways and Means, and the members ordered to prepare and bring in the bill, to be dealt with as other unopposed bills.

STANDING ORDER, No. 87.

On Thursday, Feb. 19, in the House of Commons Nos. 7, 8, and 9, of the Standing Order; No. 87 were rescinded, this will get rid of a very expensive, tedious, and troublesome part of railway proceeding, as it will no now be compulsory to produce evidence relative to traffic.

DATUM LINE, Order No. 25.

A doubt arose in the minds of the committee respecting the London and Brighton (Dorking Branch) Railway, whether the *datum* line taken from the proposed junction with the London and Brighton Railway was taken from a sufficiently fixed point, and was in compliance with order No. 25. The committee accordingly postponed their decision, but subsequently decided that in this respect the standing orders had not been complied with.

The reception of the petition of the London and South Western (Romsey and Redbridge Junction) Railway, was objected to on several technical grounds. Among other objections, it was urged that the *datum line taken from the top-water* of the Andover and Reigate Canal was not sufficiently fixed. One engineer stated that the top-water was always nearly on the same level, it being regulated by a weir, but two other witnesses gave evidence of a very different nature on this point. One of the latter, who was employed on the canal itself, stated, that so far from the weir being sufficient to preserve the level, it was very small, and when there was much water he had to open a hatch to let it flow out. The sub-committee declared that the standing orders in this case had not been complied with.

It appeared that in the North Staffordshire (Churnet Valley Line) there were three fixed points given in the plans from which a *datum* line was to be drawn, one only of which, however, was the subject of controversy before the committee. The petition stated that one *datum* line depended on a point 418 feet below the "soffit" of the arch of Cockshott-bridge, and his agent contended that this point was not fixed, but variable and uncertain. The whole turned on the meaning of the "soffit." The opponents called several witnesses, among whom were Mr. Leather, a civil engineer of some years' practice, Professor Hosking, of King's College, London, and Mr. Tite, the architect of the Royal Exchange, who stated that by "soffit" they understood the whole of the interior surface of an arch from springing to springing, and not the top or crown. One of these witnesses said, that with such a point given to him he should consider himself at liberty to take the measurement for the *datum* line from any part of the interior surface of the arch, and that, therefore, this was a fluctuating and not a fixed point. On cross-examination, most of these witnesses admitted, that from this word being used in reference to a level, they might probably suppose it meant the top of the arch.

Mr. Burke, on behalf of the line, brought many experienced engineers, among them Mr. Vignoles, Mr. R. Stephenson (the engineer of this railway), and Mr. G. B. Bidder, who proved, that whatever schoolmen might understand by the word "soffit," no doubt could exist in the mind of a practical man as to its meaning, especially in a case like this, where height or depth was to be measured from it. These gentlemen distinctly stated, that none but a tyro in engineering could suppose it to mean any other portion than the top of the arch.

The Chairman announced that the committee (No. 1) considered the standing orders complied with in this case.

The *datum* line of the Lancashire and Yorkshire North Eastern Railway, was taken on a level with the topwater of the Leeds and Liverpool canal, which would be crossed by the proposed line. The Chairman doubted whether this could be allowed as the fixed point to which the *datum* should be referred. The engineer explained that there was a weir of stone work close to the point from which the level was taken, the water had not fallen below a certain point for the last 16 years.

This being considered satisfactory, the committee decided that this bill should be reported as having complied with the standing orders.

In the committee on the Great Grimsby and Sheffield Junction Extension Railway (No. 2) Bill was opposed, and the first allegation was that the 'datum' line shown upon the sections of the plans was not the same throughout the line, as two different 'datum' lines were shown in different lengths or parts of the line. Mr. Parkes objected to the allegation that it was not sufficiently stated, but was so vague that it was impossible to find out to what part it alluded. Mr. Dernfit said that it referred to the fact that one 'datum' line was taken from the High-street at Lincoln, and the other from Grimsby Dock. Mr. Fowler said the latter 'datum' line was in a branch not included in the present bill. Mr. Dernfit said the second allegation was that the point from which the 'datum' line was taken was the level of a stake driven into the ground at the point of junction with the Nottingham and Lincoln Railway, now in course of construction; but did not state whether it was the upper part of the stake or the lower part of it. He called a gardener of Lincoln, who stated that the stake was in his orchard, next to the wall, and was the "crown stake" of the Nottingham and Lincoln Railway. There was no stake in the street. The Chairman said that it appeared the stake was not on the west side of the High-street, but in the orchard, and therefore was incorrectly described. Mr. Parkes said the reference that it was at the point of junction with the Nottingham and Lincoln line, on the west side of the High-street, clearly described the point meant, and that the stake was correctly described as being on the west side of the High-street. He called Mr. Fowler, Mr. Joseph Gibbs, and Mr. Harrington, who all said that no engineer could mistake as to the point referred to, and that they should consider the stake a fixed point as it was protected by law, it being an offense to take any of them up. The 'datum' stakes were kept standing for a long time after a railway was completed, as it was from them that the levels were kept up along the line. The Chairman said, that the Committee were of opinion that the description was not accurate enough, besides having some doubts as to the sufficiency of a mere stake as a fixed point. They must, therefore, report the case to the select committee. The standing orders had not been complied with in this case.

Subscription Contract.

When the South-Eastern (from the Waterloo-road, near the Hungerford-Bridge, to the Greenwich Railway) Railway, had been gone through, the Chairman stated that the committee (No. 3) could not decide that the promoters in this instance had complied with the standing orders, inasmuch as a considerable doubt was raised in his mind, as well as in the minds of the other members of the committee, whether the subscription contract entered into was such a one as, consistently with the intentions of the house, they could consider sufficient. The contract presented to them was one which combined several different projects, for which separate and distinct estimates had been made—*i. e.*, there were several classes of works to be constructed, but only one subscription contract for the whole, and not a separate one for each of the estimates. The contract certainly provided in its pages for the parties binding themselves only for so much as would be applicable for the particular work or works, A, B, and C respectively, to which they might have subscribed. But, in order to prove the subscription contract for A, it appeared to them it was necessary to admit the proof of that for B and C, a course which he considered was not a strict nor such a compliance with the standing orders as was contemplated.

Mr. Burke, on the part of the promoters, urged that a precisely similar contract had been considered sufficient in one case last session.

The Chairman said, that was in the case of an unopposed petition, and might have been overlooked, and could not therefore form a precedent in this instance. The question, consequently, whether this project had complied with the standing orders must remain over until he had consulted the Speaker and the different chairmen of the other committees.

An objection was made to the Staines and Richmond Railway, an account of the deposit of 10 per cent. not having been paid by the subscribers according to the provisions of the Joint Stock Act. It was admitted however, that 10 per cent. had been paid into the Court of Chancery, in compliance with the standing orders of the House of Commons, but it was contended that the deed itself proved that 5 per cent. only had been paid by the subscribers themselves.—The Chairman, after hearing the objection, stated that this point had repeatedly been decided; and that if the amount required were actually deposited in the Court of Chancery, the committee could not inquire by whom it had been paid; whether it was by the subscribers or by some person for them was quite immaterial. The chairman accordingly decided that the standing orders had been in this case complied with.

An objection was made to the subscription contract of the Ayrshire and Galloway Railway, on the ground that Richard Hodgson and William Macdonald were parties to the deed in a double capacity, as trustees of the first part, and as subscribers (with others) of the second part, and thus covenanting with themselves for the performance of certain matters; which he contended was repugnant to the practice in England and to common sense, inasmuch as it placed the parties in a position in which they might be called upon to sue themselves for a breach of their covenant.

Mr. Connell, for the promoters, stated that the contract had been drawn up in conformity with the practice and the law which obtains in Scotland, where it was competent, in certain cases, for a man to sue himself under a deed. He apprehended also that, in the case of a debt due from one member of a firm to another, the firm might legally sue that member.

Mr. R. Mackay, Writer to the Signet, on the same side, said that a legal objection had never been stated in Scotland effectually against the power of any party to sue because he was a shareholder. Under the common law of Scotland a party could sue himself. It was of daily occurrence. He had taken the opinion of the Lord-Advocate on the point that morning who ridiculed the idea that a party could not sue himself by the law of Scotland.

The Chairman desired the room to be cleared for a division. On our re-admission, he stated that, in regard to the objection of Mr. Burke, the committee had decided that the standing orders had not been complied with, inasmuch as the subscription deed was invalid, in that it did not bind the subscribers, within the meaning of the standing order 40.

The committee on standing orders confirmed this decision of the sub-committee, but subsequently in the House the Attorney General declared that the contract was not illegal, consequently the report was referred back to the committee.

Notices.—Order, No. 17.

It was contended by Mr. Connel, on the part of Sir W. Napier, that the section of the proposed Ayrshire, Bridge of Weir and Port Glasgow Junction Railway, so far as it related to the parish of Kilbarton, was not in accordance with the standing orders, in that the notice which had been served on his client, Sir William Napier, did not inform him how a road in that parish which the petitioners intended to lower 15 feet would affect him, as they were required to show in the heading of the schedule (form referred to in standing order No. 17); secondly, that in respect to the position of the road, the level of the same, and the manner in which the railway would affect it, these particulars were all inaccurately described.

The committee, after minutely examining the sections on this point, and considering the order referred to, overruled the objections.

References.—It was contended by the opposition, that a narrow strip of ground in the parish of Port Glasgow, and described as vacant ground, was in the occupation of the Gourlock Ropeworks Company, and belonged to the Glasgow and Greenock Railway Company, and not to the parties named in the book of reference.

The petitioners' agent called a witness to prove that he had made diligent inquiries as to the ownership of the land in question, and that in prosecuting those inquiries he was referred to one of the servants of the Glasgow and Greenock Railway Company, at the station adjoining this piece of land; who informed him that he (the servant) had received instructions from head-quarters to withold information from parties concerned in the projected line.

The Committee were of opinion that the petitioners had used due diligence in ascertaining the ownership of the land, and that if parties refused to give such information whereby the promoters of a railway were led into error, the allegation of error came with bad grace from such parties. Therefore, in this case, the standing orders had been complied with.

Important Decision with regard to opposing a Bill before the Standing Order's Committee.

Mr. Burke, on behalf of a petitioner against the London, Newbury and Bath Railway, stated that he could prove that the books and plans deposited in the office of the House of Commons differed from those which had been deposited with the clerks of the peace. He contended that the petition was sufficiently in compliance with standing order No. 9 to entitle him to be heard, for as the plans and books of reference were incorrect, no landowner or occupier could know whether his land would be affected or not, and, therefore, was entitled to petition.

The Chairman said he had conferred, not only with other committees, but also with other persons, to whose opinion he was inclined to bow, and he had come to the conclusion that where the objection had reference to the subscription contract, or other matter affecting the public, then any one of the public might petition. *Where there was not any party affected, then the standing order No. 9, did not apply, but it was made for the protection of individuals, where there was a party affected,* then that party must be cognizant of an assent to such petition. He would not say the party affected must necessarily be a landowner or occupier. The committee might hold that under special circumstances some other person might be affected within the meaning of the order.

Mr. Burke expressed himself much pleased at the decision, which he was certain would affect some hundreds of petitions. He then withdrew the petition.

An important allegation was made by Mr. Coates against the Bill of the Berks and Hants, (Hungerford Extension) Railway, on behalf of a petitioner opposing the bill annexed to the promoters' petition, that power was sought by the Great Western Railway Company to raise the sum of 850,000*l.*, yet the said notices did not make mention of any application to Parliament for the amendment of the acts relating to the said company, nor had such notices been published in all the counties in which the works of the said company were situate.

Mr. Pritt read the notices from the *Gazette*, and contended that they were amply sufficient, and given in compliance with the standing orders.

The Chairman desired the room to be cleared; and on our re-admission, after an interval of upwards of half-an-hour, the Chairman intimated that with respect to this allegation, the committee had come to the following resolution, namely that the committee were of opinion that the standing orders had not been complied with, inasmuch as the notices of application to Parliament to make a railway did not state the intention of the Great Western Railway Company (though subsequently stated to be the owners of the said Berks and Hants Railway) to amend their acts for the purpose of raising a further sum of money, but a separate notice of the same dates respectively was given by the Great Western Railway Company to amend their acts, yet such last-mentioned notice did not contain the names of places through which the works were intended to be made.

ROYAL OBSERVATORY, PARIS.—A contemporary states that there is being constructed on the top of this building, a study cabinet, the walls of which, as well as the ceiling, are of pure crystal. It is in this chamber that M. Arago will work and watch the stars, planets, and comets, by the assistance of a monster telescope, which is now being made. It is expected that this new transparent observatory will be terminated by the month of July next.

The *Dauntless* and *Arrogant* frigates, on the designs respectively of Mr. White, of Cowes, and Mr. Fincham, master shipwright of this establishment, are progressing very rapidly towards readiness for launching; their timbering is finished, and their ceiling and planking. The Dauntless (Mr. Fincham's design) is intended as a steam frigate, but the Aorrgant will only have steam as an auxiliary to work a screw. The following are the principle dimensions of the Arrogant. Length between the perpendiculars 200 feet; Length of keel for tonnage, 175 feet; Breadth extreme, 45 feet, 4 in; Breadth moulded, 44 feet; Depth of hold, 23 feet; Burden in tons, 1,800; Horse-power for screw, 390. This fine ship is in the most forward state of the two, and presents a boldness of outline very much admired by all who have seen her since she has been planked. She presents a very handsome looking model, and is expected to prove a perfect man of war.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM JANUARY 29, 1846, TO FEBRUARY 25, 1846

Six Months allowed for Enrolment, unless otherwise expressed.

George Frederick Hall, of Norfolk-street, Fitzroy-square, in the county of Middlesex, pawnbroker, for "certain machinery or apparatus for writing and booking, numbering, cutting, checking, and expediting the delivery and receipt of pawnbrokers' duplicates, pass-tickets, and other like documents."—Sealed January 29.

James Brown, of Ball's-row, High fields, Coventry, for "certain Improvements in weaving."—January 29.

Augustus Turk Forder, of Leamington Priors, in the county of Warwick, solicitor, for "an Improved pump or engine for raising and impelling inelastic fluids, and producing motive power."—January 29.

Charles Cowan, of Valley-field mills, in the county of Edinburgh, paper manufacturer, for "Improvements in the manufacture of paper mill-board, and other similar substances."—January 29.

John Greenwood, of Church, in the county of Lancaster, manufacturing chemist, for "Improvements in dyeing Turkey-red, and other colours."—January 29.

George Howell, of Larkhall-lane, Clapham-common, Surrey, for "coating with a metal the surface of articles formed of copper, or copper alloys, or iron, whether wrought or cast." (Communication.)—January 29.

Michael Rimington, of No. 10, Rufford-row, Islington, in the county of Middlesex, gentleman, for "Improvements in obtaining and applying motive power." (Communication)—January 31.

George Hinton Bovill, of Millwall, in the county of Middlesex, engineer, for "Improvements in the manufacture of iron."—January 31.

Andrew Etienne, of Hatton-garden, in the city of London, gentleman, for "Improvements in the construction of railways, railway carriages, and in the means of preventing accidents on railways."—January 31.

James Pilbrow, of Tottenham, in the county of Middlesex, civil engineer, for "certain Improvements in propelling on land and water."—January 31.

Henry Highton, of Rugby, in the county of Warwick, master of arts, for "Improvements in electric telegraphs."—February 3.

Edwin Chesshire, of Birmingham, surgeon, for "Improvements in apparatus to be applied to railway carriages to reduce the prejudicial effects of collisions to passengers in railway carriages."—February 3.

Samual Brown, of Gravel-lane, in the county of Surrey, engineer, for "Improvements in gas engines, and in propelling carriages and vessels."—February 3.

Thomas Foxall Griffiths, of Wolverhampton, for "Improvements in stamping and shaping sheet metal."—February 3.

William Garnett Taylor, of Halliwell, in the county of Lancaster, cotton spinner, and William Taylor of Halliwell, aforesaid, labourer, for "Improvements in consuming smoke and economising fuel."—February 3.

William Malligan, of Bradford, in the county of York, manufacturer, for "certain Improvements in the power-loom."—February 4.

William Greener, of Birmingham, gun maker, and William Edwards State, of Peckham, Surrey, esquire, for "improved means of ignition and illumination."—February 7.

Thomas Clarke, of Hackney, Middlesex, engineer, Mark Freeman, of Sutton, in the county of Surrey, gentleman, and John Varley, of Poplar, in the county of Middlesex, for "certain Improvements in obtaining and applying motive power, parts of which are applicable to the regulating and controlling of fluids."—February 11.

James Palmer Budd, of Ystalyfera Iron Works, Swansea, merchant, for "Improvements in the manufacture of iron."—February 11.

John Keating, of North-mews, Fitzroy-square, in the county of Middlesex, scagliolist, for "certain Improvements in the manufacture of cement."—February 11.

Joseph Pierre Gillard, of Rue Martignac, in the city of Paris, professor of mathematics and philosophy, for "Improvements in the production of heat in general."—February 11.

Charles Tetley, of Bradford, in the West Riding of the county of York, stock and share broker, for "certain Improvements in machinery for raising and impelling water and other liquids, and also thereby to obtain mechanical power."—February 11.

William Edward Newton, of Chancery-lane, in the county of Middlesex, civil engineer, for "Improvements in the construction of instruments or apparatus for ascertaining, registering, and regulating the speed of carriages and machinery." (A communication.)—February 11.

Andrew Smith, of Prince's-street, in the county of Middlesex, engineer, for "Improvments in coating or covering metals for the purpose of preventing oxidation."—February 11.

Alfred Vincent Newton, of Chancery-lane, mechanical draughtsman, for "certain Improvements to be applied to the grinding of grain and other substances."—February 11

James Murdoch, of Staples-inn, in the county of Middlesex, mechanical draughtsman, for "an Improved process for preparing a certain material for the purpose of painting." (A communication.)—February 11.

George Stevenson, of Tapton-house, Chesterfield, in the county of Derby, engineer, and William Howe, of Newcastle-upon-Tyne, in the county of Northumberland, mechanic, for "an Improvement in locomotive steam-engines."—February 11.

William Wharton, superintendent at the Euston-square station of the London and Birmingham Railway, for Improvements in straps and bands."—February 11.

Charles Rowley, of Birmingham, button manufacturer, for "Improvements in buttons and other fastenings for wearing apparel, and in the machinery for manufacturing parts of the said fastenings."—February 18.

John William Stanbridge, of 38, Brudenell-place, New-road, Middlesex, gentleman, for "an Improvement in the manufacture of certain descriptions of silks and other fabrics."—February 18.

John Brocklehurst, of Holborn, in the county of Middlesex, lamp manufacturer, for "Improvements in the hanging and disconnecting of window sashes and frames."—February 11.

James Nasmyth, of Arundel-street, in the county of Middlesex, gentleman, for "certain Improvements in engines or machines for obtaining and applying motive power."—February 16.

William Edward Newton, of Chancery-lane, in the county of Middlesex, civil engineer for "Improvements in the preparation or manufacturing of thread or yarn." (A communication.)—February 17.

Jacque Cloet, of Manchester, in the county of Lancaster, gentleman for "a certain Improved combination of materials to be used as a substitute for leather or for waterproof cloth and other similar useful purposes."—February 17.

Juan Nepomuceno Adorno, of Mexico, in the republic of Mexico, gentleman, for "Improvements in manufacturing cigars and other similar substances."—February 17.

Edouard Auguste Desire Guichard, of Rue des Feuneurs, Paris, in the kingdom of France, for "Improvements in printing calico and other fabrics."—February 17.

Stephen Etievant, of Church-street, Soho, in the county of Middlesex, for "Improvements in stoves." (Communication.)—February 17.

Nicholas Francois Corbin Desboissierres, of Rue Saint Pierre, Montmartre, in the Kingdom of France, gentleman, for "Improvements in preparing and burning fuel."—February 17.

Joseph Clinton Robertson, of 166, Fleet-street, London, civil engineer, for "Improvements in nail making machinery." (Communication.)—February 18.

Robert Nisbet, of Lamden, in the county of Berwick, esquire, for "certain Improvements in locomotive engines and railways."—February 19.

Peter Claussen, of Leicester-square, Middlesex, esquire, for "certain Improvements in machinery for weaving, and in preparing materials for weaving." (Communication.)—February 20.

John Platt, of Oldham, in the county of Lancaster, machinist, for "certain Improvements in machinery or apparatus to be employed in the preparation and spinning of cotton and other fibrous substances."—February 25.

John Britten, of Liverpool, chemist, for "certain Improvements in the method of applying heat for the purposes of heating, cooking, and evaporating, and in the apparatus connected therewith."—February 25.

Peter Bancroft, of Liverpool, merchant, for "certain Improvements in the method or process of refining and purifying animal and vegetable oils and grease."—February 25.

John Harcourt Brown, of Brunswick-place, Barnsbury-road, gentleman, for "Improvements in securing letters, envelopes, covers, despatches, packets, and parcels."—February 25.

Thomas Murgatroyd Dean, of Stockport, in the county of Chester, engineer, for "certain improvements in machinery or apparatus applicable to to the furnaces or fire-places of steam-engines or other boilers."—February 25.

Moses Poole, of the Patent Office, London, gentleman, for "Improvements in cleaning and separating grain and other seeds." (A communication.)—February 25.

Antonio James Mayer, of Ashley-crescent, City-road, for "Improvements in certain wood-cutting machines."—February 25.

Josue Heilmann, of Mulhausen, in the Department Du Haut Rhin, France, machine maker, for "Improvements in certain machines used for preparing to be spun cotton, wool, and other fibrous materials."—February 25.

William James Cantelo, of Paris-street North, Lambeth, for "Improvments in apparatus for hatching eggs and raising the young, and for heating hot-houses and other buildings."—February 25.

Thomas Pemberton, junior, of Birmingham, manufacturer, for "a new or Improved method, or new and improved methods of ornamenting window-furniture and articles of upholstery in general."—February 25.

William Robertson, machine maker, of Gateside, Renfrewshire, for "certain improvements in the machinery for spinning and twisting cotton, silk, wool, flax, and other fibrous substances."—February 25.

George Alexander Thompson, of Connaught-terrace, Hyde-park, gentleman, and Joseph Wright, of Holborn-bars, mechanic, for "Improvements in propelling vessels."—February 25.

John Maddock, of Binstern, Stafford, earthenware manufacturer, for "a new and improved method of building and constructing kilns and ovens used by potters and manufacturers of china and eathenware."—February 25.

CORRESPONDENTS.

Mr. Foster's book on Book-keeping relates to subjects which do not fall within the scope of this Journal.

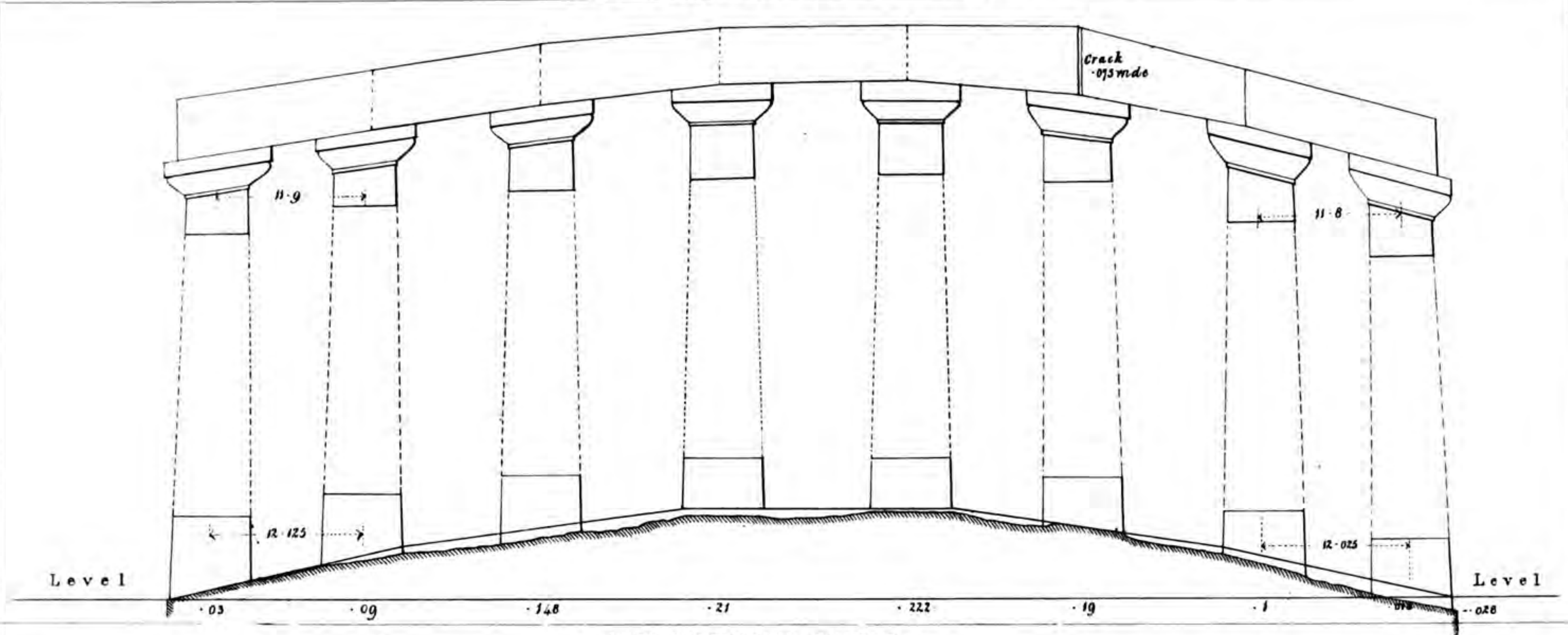
Received—Mr. Neville's paper "on the pressure to sustain banks of earth;" notice of this paper is in type, but is unavoidably postponed to next month.

The notices of new and restored churches in the present number are abridged from the Ecclesiologist.

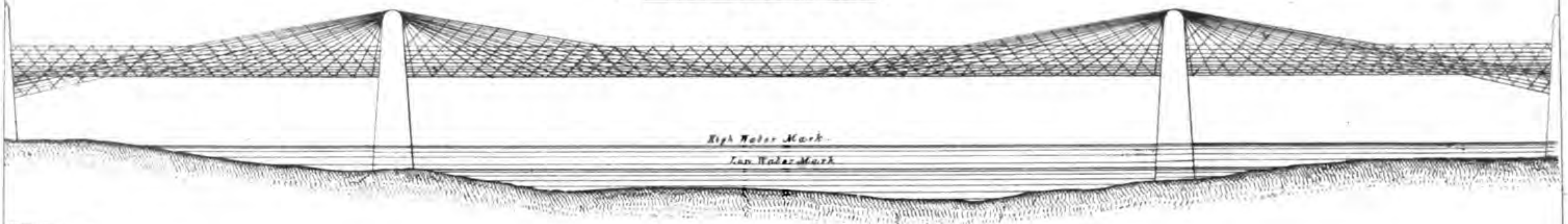
Can any of our readers refer us to books or documents containing the history of St. Margaret's Church, Westminster, and detailing the nature of the modern alterations.

M. The restorations of Notre Dâme at Paris are made at the expense of the French Government.

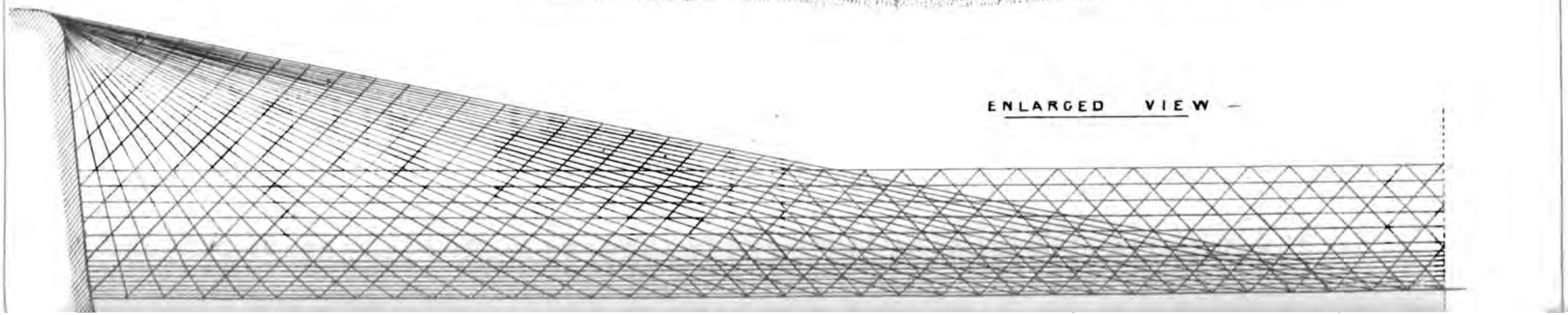
EAST FRONT OF THE PARTHENON –



AUST SUSPENSION BRIDGE –



ENLARGED VIEW –



ON THE ENTASIS AND OTHER CURVED LINES OF THE PARTHENON.*

By F. Penrose, M.A., Magd. Coll., Cambridge, Associate of the Institute.

Read at the Royal Institute of British Architects.

(*With an Engraving, Plate V.*)

It is an admirable principle of this Institution that it has for its object the bringing together of various points of information from its different members, inasmuch as no *one* can see or understand everything. It would be contrary to the spirit of this proposition, to expect that no one should get up here to speak who had not materials for an entire evening's lecture. In accordance with these views I shall only detain you a short time, to inform you of the results which I have arrived at, in a limited survey of the Parthenon; all the measurements I took having reference to its scientific, not its decorative construction.

It is a very convenient season for such discussion, after the very edifying and agreeable evening which we passed here on the last occasion of our meeting, when the zeal of Mr. Lucas and the remarks which he called forth from Mr. Donaldson, brought the subject so vividly into discussion.

However I will proceed at once to what I have to say—The first point to be considered is the curvature of the steps—it is obvious that the earlier investigators of the Parthenon had no opportunity of observing this as the ground was covered with rubbish, and it is so slight as to elude the eye unless brought down to the level of it.

Had Vitruvius however been in credit, the following passage would have sufficed to suggest it, "The stylobate or step should be so set out as to have in the middle an addition by means of unequal *footstools* (literally), *i. e.* unequal blocks. For if it be made level, it will appear to the eye sunk in the middle (literally channelled) to the eye." Again, "When the capitals are finished they must be arranged on the shafts of the columns, not level, but according to the same measurement as before, so that the symmetry of the architraves and upper members may correspond to the same addition as was made in the stylobate."

This was first observed in the Parthenon, I understand, by Mr. John Pennethorne. He unfortunately, however, allowed the Germans to have the credit of prior publication; it made its appearance in a Vienna architectural journal, four years ago. I have a drawing (see plate), made from my observations of the east front of the Parthenon. I levelled it, I believe, very correctly, as my instrument, on being taken to the opposite end, gave exactly the same line. I have drawn a black line along what I suppose to have been the original line; the shaded line marks that which I obtained from my measurements; these, in which I was assisted by Mr. G. Kennedy, were taken with the French metre, and I have reduced them to English feet and decimals of a foot, which, I think, is the best system we can use for scientific mensuration—it were much to be wished that it should become universal. A circumstance which would render this change less troublesome to workmen is, that the 100th of a foot is nearly the same as the eighth of an inch.

Now, observing that the sixth column from south-east angle is the highest for its situation of all the columns, and that the architrave above has a crack about ·06 feet in width, I infer that that point has been set most firmly in the foundation, and the rest have all settled more or less about it. This may perhaps have been all the result of earthquakes, as I found that the base of the central columns of the west front were ·08 feet higher than those at the east end, and the base of the south angle column of west front was ·09 feet higher than that at its north angle.

In the east front it will be seen by the drawing that the north-east angle of upper step is ·028 feet lower than south-east angle, showing a settlement in that part of the building, which is also attested by the aforesaid crack over the architrave of the sixth column. It will be seen that on the south half of the front the step runs very nearly straight, except that at the angular column there is a little more shoot, probably to throw off the water better. And the angular column is about ·02 feet longer than the others to compensate for this. The step, at this point, has a gradient of about $\frac{1}{130}$, afterwards $\frac{1}{350}$ nearly. The chief rise is ·022 feet, which is about the same as the amount which the columns lean from the perpendicular. The height above level of fourth column from the east on the south flank is ·28. It is quite clear that the step has been lowered a trifle by settlement, as the stones of the step immediately under the columns adhere so closely that they have actually grown together, as Stuart found to be the case; but lower down the joint is apparent enough.

An hyperbola may be drawn approximating very nearly with the line after allowing a very little for these settlements, which have unquestionably taken place, and as the conic sections have been applied constantly in the construction of this and the other temples at Athens, I think it not improbable that they were regulated in this matter by that curve.

Can any geometrical or optical considerations suggest the necessity for this addition in the middle of the step?

Vitruvius does not go so deep into this as he usually does on optical questions; he merely says that the step if level will look channelled. It occurs to me that it is in the pediment and not in the step that we are to look for the necessity of this correction.

It is a matter of constant experience that the presence of a curved line distorts any right line in its vicinity, as for instance, the tangent to a circle always looks bent contrary to the curvature of the circle, and the same thing is no less true of the chord. A small segment of a large circle may be made to look straight, or even bent contrary to its real direction, by the juxta-position of a curve of greater curvature.

The same thing obtains more or less in a pediment where the converging lines have ultimately exactly the same relative position as an arc and its chord. And any portico to which these corrections are not applied will give something of this feeling, if we look attentively at its angles. Another confirmation of this view of the matter is, that in the great temple at Pæstum, (undoubtedly built some time before the temple of Theseus,) the addition to the stylobate and entablature is applied only at the ends; the flanks are horizontal. At Segeste, whose greatness is probably posterior to the glorious days of Athens—and consequently their temple is to be referred to a later period—the addition is on all sides as at the temples of Athens. This adjustment could only be required in temples seen directly opposite. So in the Propylœa, we do not find any addition made to the stylobate.

We have heard something of a curvature of the entablature in an horizontal plane as well as the vertical. Mr Lucas stated last meeting that he understood from Mr. Pennethorne that such was the case. I admit that both the fronts of the Parthenon are bent inwards, but not that it was so originally.

In the east front of the Parthenon the four first architrave stones are in a continuous plane nearly vertical; the fourth is bent slightly inwards away from this, the rest are quite irregular. The entire deflexion in the east front is not more than ·09 feet.

I observed that the joints of masonry on the fronts are almost all crushed, so that it is clear that there has been a slight disturbance of the original plane of the building; indeed, the angular columns give less declination than the central ones.

I found that the fourth column from the south-east angle leant ·285 feet; (this is the same as that given in the supplement to Stuart.) From the north-east angular one I deduce ·225 after allowing for the amount of settlement due to the crack above the sixth column. I cannot admit that such horizontal curvature was ever intended. Vitruvius does not mention it, nor can any reason be assigned that I am aware of for the use of it. Constructive and optical advantages are obtained both by the leaning of the columns and the raising the stylobate and epistyle. It is evident that, in a country liable to earthquakes, a certain degree of pyramidal construction given to the building must be of statical advantage. The slight disturbance which has actually taken place has thrown the north-east angle column about ·07 feet to the right hand, and it would have leant away from the building in an unsightly manner had not there been an original declination three times as great inwards.

Still I do not compare my argument *a priori* with that drawn from marks of crushing and settlement on the building. As Wilkins fell into a sad mistake when commentating on these very subjects in Vitruvius, when he states his belief that it was only a fancy of Vitruvius, and did not enter into the works of the ancients. Vitruvius is very positive about the leaning of the columns, and states that their inner face should be parallel with the wall of the cella. The columns of the Parthenon have not nearly so much lean as this, however owing to the nature of the curve of their

* The curvature of the stylobate of the Parthenon is briefly noticed in the Seventh Volume of this Journal, p. 16.

entasis, they are so at their springing, which may perhaps be Vitruvius's meaning, as there is no instance, except, I believe, the temple at Tivoli, of so great a declination as he describes. It was well known generally among the ancients that such was the case. Cicero relates an amusing story, in his oration against Verres, how Verres was very anxious to do something in the building way, and restore a certain temple of Castor at Syracuse. He came into the temple, and on examining it, found every thing sound and in good repair. He turned about him, and asked his confidentials what he should do. One of them jokingly said, "Why, Verres, you have nothing to do here, unless, perhaps, you would like to set the columns perpendicular." That man (Verres), most ignorant on all subjects, asks, "What do you mean by perpendicular?" They answer him, that there was hardly any column which could be perpendicular. Then said he "By Hercules, let us do so, and put them perpendicular." Cicero thus holds up Verres for derision, for being ignorant on matters of taste.

It seems to me that the following consideration suggested the inclination given to the columns:—In consequence of the diminution of the columns, the upper spaces become larger than the lower, and as the eye measures the whole length of the architrave by the sum of the intercolumniations, it would appear longer than the step, and consequently the columns would appear to diverge from the ground, unless such inclination be given to the angular columns as shall correct this false impression.

Vitruvius states that all the members above the capitals should lean outwards $\frac{1}{12}$th of their height. This, I believe (and I have seen some very careful measurements of Mr. Scoles's, made with reference to this), does not obtain in any Greek building. The corona of the Parthenon, indeed, has an inclination outwards of 1 in 100, but all the rest of the members lean inwards in the direction of the columns; it is clear that $\frac{1}{12}$th would be too much, and especially at the angles would appear nearly $\frac{1}{8}$th, which would look preposterous. I have no doubt that the $\frac{1}{12}$th in the text of Vitruvius is corrupt, or else Vitruvius must have generalised too much; I should prefer the former hypothesis.

There is a small difference both in the west front and east front. In the outer intercolumniations of the Parthenon, that to the south is in both fronts about $\frac{1}{10}$th of a foot wider than the northern one. Can this have arisen from a desire to make the intercolumniations towards the south—which are more seen, both on account of sun and situation—more nearly equal to each other? In the temple of Theseus the same holds but *vicè versâ*. In both cases the addition is given at the side which from its position is most commanding.

The joint of the stone of the architraves next the angles is on both sides made to lie a little within the centre of the column (or towards the centre of portico), by means of which the two metopes next the angles are squares, and the next two differ, by a small quantity, from that figure. It must have been thought that it was more important to get the angular metopes exactly symmetrical on each face, than two contiguous ones on the same face. This adjustment, however, is not so apparent on the flanks and west front as it is in the east front; but the east was the principal front theoretically, though in the Parthenon the west front was seen more from the town.

There are some small and curious varieties in the abacus in different parts of the Parthenon. The more ordinary one on the east, west, and north sides is $\frac{1}{15}$th upper step. The abacus of the angular column is $1\frac{1}{4}$ Attic dactyli, or nearly $\frac{1}{80}$th greater. I divided $\frac{1}{100}$th of the upper step of the Parthenon (*i. e.* one Attic foot, according to the Greek fashion) into 16 dactylii, and have found these divisions to agree very well with the smaller dimensions, which were taken by myself as well as by others, and with fragments in the British Museum.

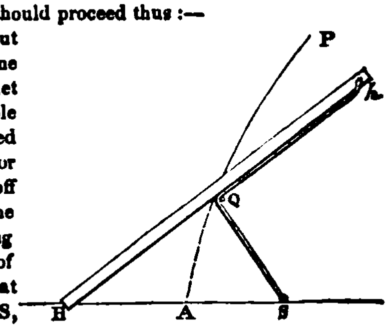
If the abacus be divided into 30 parts, 28 such parts will give the lower, and 22 parts the upper, diameter of the column. The angular abacus is $\frac{1}{5}$th the height of the column; the thickness of this abacus is $\frac{1}{4}$th of its breadth. On the south side every abacus is less by ·2 feet than those on the north side and fronts, and is equal to $6\frac{1}{4}$ Olympic or Attic feet, or $\frac{66}{1000}$ of upper step.

These capitals, being always seen either from the city below, or from the very narrow space between the temple and the wall, on the platform itself of the Acropolis, in quick perspective, a large portion of their under surface would be seen, which would give them a greater appearance of size than the others, which are not generally viewed from a similar situation, and which would, therefore, appear more as in elevation. The abacus in the British Museum is from the south side.

I now come to the entasis of the columns. In the Parthenon it is so slight as merely to correct the false impression which the eye always receives from columns whose sides are really straight lines, for the eye naturally fixes upon and measures the column at the neck, and the springing or base, but has nothing to compare it with in the middle, so it loses at that point in importance and requires compensation.

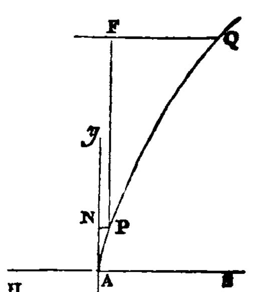
The entasis of the columns of the Parthenon is about that which would be given in an Ionic column of the same height, according to Vitruvius's rule, viz., the thickness of the fillet of one flute. I have found, from measurements taken at the edge of the flutes, that this curvature results from the columns being hyperboloids of revolution. The generating hyperbola has a principal axis equal to 1 Attic foot, a focal distance equal to 30 Attic feet; *i. e.*, the distance between foci is equal to 60 Attic feet, the line of the foci at a distance of twice the abacus below the upper step.

It is well known that the conic sections have been used very generally in these Greek buildings, but I am not aware that the exact nature of the entasis has been before demonstrated. In confirmation, I will only appeal to Mr. Scoles. Hearing that he had some accurate measurements of one of the columns, I asked him for his vertical measurements, and promised to bring him the horizontal diameters corresponding. On comparing these with his measurements the coincidence was so striking that I am morally certain that I have obtained the true nature of the curve. I have also consulted the dimensions of the columns of the Parthenon, given in the supplement to "Stuart's Athens," with a highly satisfactory result; I have also found the columns of the Theseus to be hyperbolic. A curve obtained geometrically with line and rule, owing to the unequal action of the elasticity of the string, gives a trifling deviation from the curve obtained by calculation, and approximates still nearer to the entasis of the columns. It is not to be supposed that, in forming their columns, the Athenian artists struck the hyperbola full size, for then they would have required a straight-edge about fifty feet long, which would have been very unmanageable; but any hyperbola, constructed with the same principal axis, viz., $a = 1{\cdot}013$ feet, will have its horizontal abscissa full size, and the vertical ordinates in some proportion, which can be easily determined. Consequently, to obtain any number of dimensions for constructing a column like those of the Parthenon we should proceed thus:—



Take a straight-edge H h, about five feet long; fix a string at one end of this straight-edge h, and let the other end traverse, upon a table or drawing-board, round a fixed point, H, by means of a pin or awl. Let the string be cut off exactly 2·025 feet shorter than the length, H h, of the rod. The string being fixed to the moveable end of the rod h, and to a fixed point S at some convenient distance H S, from H, viz., about three feet.

Now let the straight-edge revolve about H, and keep the string tight against it with a pencil, as at Q; thus will an hyperbola, P Q A, be traced on the board, having all its horizontal dimensions equal to the real size, and its vertical according to some scale which can be very easily determined:—



Draw A Y perpendicular to H S, and, at a distance, N P = $\frac{1}{11}$th of the axis we have been using, viz., $\frac{1{\cdot}013 \text{ feet}}{11} = {\cdot}092$ feet, draw P F parallel with A Y. Then set off F Q = ·696 feet, which is equal the entire diminution of the column, and the segment Q P will be proportional in height to the shaft of the column, and if it be divided so as to represent 31·4 feet, the scale so obtained will give the full size entasis at any point required.

A somewhat similar method may be used to obtain any desired entasis for any column that may be required, having first fixed upon the amount of the entasis and the diminution of the column by first drawing the curve as here described, with any convenient axis and foci, and then applying a straight-edge until we get exactly or approximately the amount of entasis and diminution required; dividing the length of the arc so obtained for a vertical scale of the column; but as this implies something of the loose nature of a tentative process, it would of course be more satisfactory to fix exactly the upper, lower, and middle points of the proposed curve, the distance below the springing of the focal line, and then obtain the curve by an analytical, or, when possible, by a rigid geometrical process; the first method, however, is very easily done and capable of great exactness.

The hyperbolic form is admirably adapted for Doric columns. The conchoid of Nicomedes, which is so very beautiful in Corinthian, has a point of contrary flexure near the neck, which is inconsistent with the solidity and dignity of Doric.

Before I leave this subject I will say that by slightly modifying the points, &c., and string in the geometrical drawing of the hyperbola, multitudes of beautiful curves are produced, some of which are very like those of the vases and amphoræ of antiquity. There can never be any need of drawing curves arbitrarily by eye, as there are an infinite variety of regular curves, suited to every possible want of art or science. I cannot help alluding to the exceeding beauty of the curves produced by Professor Willis by his epicycloidal chuck.

Are these isolated principles? Or are they not rather connected by some one beautiful connecting link?—I cannot yet attempt to decide: something must have been left to the eye and judgment. But it would be extraordinary that such wonderful adjustments—such subtle corrections, worked too with such precision and geometrical accuracy, should be in each case merely empirical. Without the most accurate measurements of these small differential quantities, taking into consideration every crack and movement among the blocks of marble, it must be hopeless to discover it. There is ample field for a work which shall be the standard of the scientific, as that of Stuart is of the decorative architecture of the Greeks.

Reference to the Engraving.

The engraving is a sketch showing the rise in the stylobate and the inclination of some of the columns in the East front of the Parthenon. The differences in the steps, &c. are drawn to a scale equal to one-fifth of the real size, and the remainder one 150th of the real size. The dimensions are given in feet and decimals of a foot; the figures under each column show the height of the steps above or below the level line. The irregular line at the foot of the columns shows the existing line of the steps, and the line above it the probable original form.

The upper and lower courses of the columns are the *scamilli impares* of Vitruvius; all the rest are symmetrical and perpendicular to the axis of the column. The left hand outer column leans to the right ·206, and the right hand one leans to the left ·15.

THE DECORATIONS OF THE OPERA HOUSE.

The example that is to be, of the New Palace of Westminster, and which is now only *in prospectu*, may be said to be operating by anticipation. All branches of decoration connected with architecture are, in city phrase, *looking up*, and even mural pictorial embellishment, in encaustic, if not yet in fresco, has begun to be introduced among us,—and that, perhaps, with more hurry than good speed. What was the first application of it is by no means a very prepossessing specimen, the decorations in the arcades of the Royal Exchange being almost ludicrously inconsistent with the purpose of the building,—so greatly at variance with all propriety of character, that were they very much better both as to execution and general effect, they would still be unsatisfactory. Strange to say, although *Decoration* would seem to hold out the fairest opportunities for the exercise of inventive talent and the indulgence of fancy, it seems to be shackled by and under the thraldom of "Precedent." Even in Ornamentation we either can, or else allow ourselves to do nothing without asking permission of Precedent. Our most approved novelties—our newest fashions in furniture and the fitting-up of rooms seldom amount to more than the re-introduction of obsolete and by-gone ideas,—not of ideas legitimately borrowed in order to be modified and so remodelled as to be made our own, but taken bodily, and copied with scrupulous exactness, on which very account what is intended for fidelity becomes no better than absurdity, and what was excellent in its own time—in accordance with the spirit and circumstances of that time, is rendered more or less ridiculous by misapplication. We hug and pique ourselves upon our wonderful talent—the only wonder being that it should be thought such—for imitating what has some time or other been done before. We plume ourselves upon being *plus arabe que l'Arabie*,—more Pompeian than Pompeii, more *à la Quatorze*, than the great Louis: All *à la grecque* and *à la Hope* one day, we are all Elizabethan the next; Renaissance, and Roman, by turns; Gothic or Grotesque, according just as fashion dictates.

The Opera House has just been embellished *à la Raffaellesque*, and by good luck—by sheer good luck it happens that that style—in reality the *à la* Titus is admirably well suited for the decorations of such a place, it being playful, poetical, and fantastic enough, for which very reason the application of it to a *pontifical* palace becomes somewhat questionable, not but that it would have been highly commendable in some of the successors of St. Peter had they emulated the noble example of Titus himself. By those who have spoken of them, great stress is laid upon all the decoration of that theatre being taken *verbatim* from accredited authorities. We are awed into admiration by the names of Raffaelle, Romano, De Udine; such piece of ornament, we are assured is from Genoa, another from Mantua. Then we have Guido's Aurora on the sofitte of the proscenium—which if not poignantly satirical, is admirably appropriate, twelve o'clock at night being the hour when the votaries of Fashion shout out

"Uprise ye then,
My merry merry men,
This is our opening day!"

Whether any of the miniature *subjects* in the panels on the fronts of the boxes be immediately taken from Raffaello and his contemporaries or not, is of very little moment, since as subjects they are utterly lost, and a few dabs of colour would show just as well, it is enough that the general effect is good,—light, sportive, fantastic, and not overloaded with meaning! This so to call it, unmeaning arabesque style of decoration may be allowed to be admirably in keeping with the lyric or musical drama, both being *outré*, and avowedly imitating nature only at a very great distance, and exceedingly conventionally: the nature of both is the nature of fairy-land, and only a formal blockhead would object to them that they are nature *à la lettre*. Arabesque may be regarded as the musical style of the pictorial art, and as distinct from subject painting as singing is from speaking. It is only the ultra-prudery of common sense that objects to such application of the pencil as nonsensical and absurd. In fact it is its vagueness and want of express meaning, together with its renunciation of any pretension to imitate natural objects *naturally*, that render this mode of painting preferable to *picture* in direct imitation of nature, for being allied with architecture so intimately as to assume somewhat of the nature of the latter art. Free and playfully fanciful, it is at the same time architectonic, accommodating itself spontaneously to linear and symmetrical arrangement.

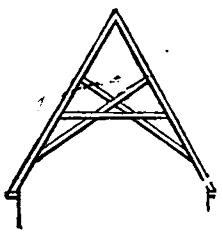
One very great thing in favour of the pictorial embellishments of the Opera House is that they are seen only by artificial light, which sheds over them a glow whose very warmth sobers them, whereas by day painting of the kind is apt to look garish if not tawdry. In a theatre it is in its proper element, the very atmosphere of the place being artificial; and where all is artificial, the artificial becomes the natural. Had there been even less of "picture" introduced—or we might say dragged in among the properly so-called pictorial decorations, better taste would, we think, have been shown. Besides Guido's Aurora over the proscenium there are four circular compartments in the ceiling containing copies of Albano's Seasons. In what respect they are at all significant we cannot divine:—there are not four, but only one Opera "Season" in the course of the year. Inapplicability of subject we could, however, wink at; but besides that we protest against the absurdity of sticking up "pictures" upon a ceiling where as "pictures" they can not possibly be properly seen,—and here they show only as mere spots,—even as panels in the ceiling, those compartments are quite at variance with sound architectural design and combination. Nor do we scruple to say this, although the ceiling is said to be taken from one in the celebrated Villa Madonna at Rome. We can only say, pity that instead of being *taken*, it was not left where it was found; and that Mr. Johnson, the commander-in-chief of the artistical forces employed, did not set his wits to work, and devise something better of his own.—As to the "*house*" itself, it is by no means a model for a theatre: all that it has of proscenium is confined to floor and ceiling between the orchestra and curtain, the boxes being continued quite up to the latter, so that the audience are almost mingled with the actors.

NEW CHURCHES.

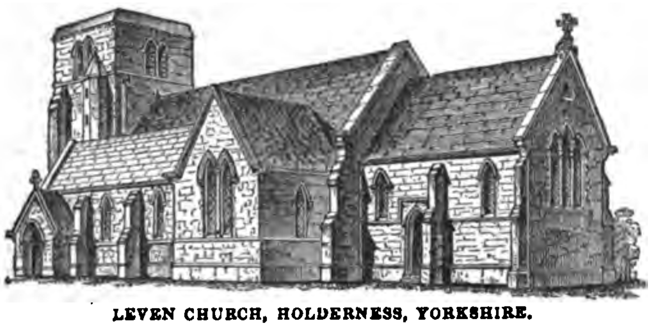
SIR—Will you allow me to notice the inaccuracy of the account of All Saints Church, Rise, Yorkshire, extracted from the *Ecclesiologist*, and given in your last number?

For that account, should be substituted,—That this church consists of a chancel (correctly proportioned) and nave, with a south porch, a massive tower, and broach spire, "in the first pointed style;" the nave will seat 220 persons; the cost is about £4,000. The exterior is wholly of Yorkshire (West Riding) grit stone, in regular courses, backed with brick; all the inside arches and splayed jambs of the windows and jambs of doors are dressed stone; the nave walls are plastered, but two lines of scrolls are cut out and filled in with Martin's cement, which is used to cover all the walls of the chancel. The east window is a triplet, plain outside, but inside, the arch is richly moulded and supported by detached pillars. The chancel pillars and arch are old, and were found in the old walls in so perfect a state as to be used with safety in the new building.

This church was built for Richard Bethell, Esq., upon the site of the old church, near his mansion. Hot-water pipes are laid under the middle aisle from a furnace and boiler, built externally; the pipes are covered by cast brass gratings. The whole of the chancel is paved with Messrs. Minton's encaustic tiles, and round the altar the wall is covered with figured tiles up to the window sills. All the seats, pulpit, lectern, stall ends, &c., of chancel, are of Norway oak. The roof has no *beams*, but is of the early form, found at Howden, Hemsworth, Fenton, Cottingham, the Augustines, London, and many others, which, when left open, are, after five centuries, found in a perfect state. Each rafter forms a perfect truss; the spaces between them are usually 18 to 22 inches; these fir trusses are *painted as oak*, all the boarding a pale azure, with gilt stars, *shaded*, taken from an old boarded ceiling in St. Mary's Church, Beverley. From authority of ancient decorations in England and on the continent, the walls are coloured drab or stone—the scrolls as parchment, rather lighter than the walls, margined with lines of scarlet —the texts in the characters preceding the Black letter (*novissima monachates*). All the pillar shafts are crimson; the lesser mouldings of the caps and bases are gilt, the hollows azure; the arches red and blue, with the under sides of the moulding covering them gilt. The stone reveals of the windows are coloured with water colour—pale blue; the light reflected from this pale blue is very considerable, and was shewn to great advantage during the execution of the work, as the stone absorbed the light. A cornice of wood covers the walls, which has the three primary colours introduced, the gilding, answering for the yellow, is narrow in proportion to its intensity, or rather, brilliancy. The painted glass windows, by Wailes, are good: the only fault being in the *imitation of old and defective glass* in some portions.



From the account in the *Ecclesiologist*, one should be led to suppose that this was a small extravagant building, filled with gaudy decorations and quackery: whereas it is a plain substantial edifice, the material coursed, as was the practise with the ancients, and it is founded on the true *masonic* principles, even to the mouldings—*nothing strictly copied, but composed.* No two buildings are to be found alike,—and why? Simply for this reason: that the principle, *on having the key*, is inexhaustible; and, by

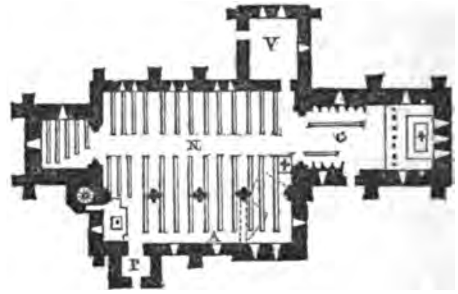


LEVEN CHURCH, HOLDERNESS, YORKSHIRE.

working upon that *key*, minutes will suffice to produce new subjects, where days may be expended in copying. Almost every ancient church, too, contains the diagram, upon which it has been composed.

I enclose you a sketch of a small village church, which is formed upon that diagram, built at Leven (four miles from Rise), and which is little more than a restoration of the old church of Leven—the old pillars, arches, font, piscina, and other portions are used in the new building; the church was dedicated to St. Faith. At the end of the south aisle was a chantry; part of the old rood was found and removed there.

As I am anxious to reform many of the errors into which modern architects have fallen, I will shortly send you some practical observations



PLAN OF LEVEN CHURCH.

N, Nave.—A, Aisle.—C, Chancel.—V, Vestry.—P, Porch.

which I have made on ancient ecclesiastical works during the last twenty-five years or more. I am, Sir,

Your very obedient servant,

London, March 10th, 1846. R. DENNIS CHANTRELL.

P.S. I have now some new churches in progress on this principle—first pointed," at Halifax; "second" (decorated), at Huddersfield and at Leeds; "third" or perpendicular, at Keighley, which latter, though perfect as a building, must be degraded by galleries, which I cannot acknowledge as in any way belonging to the building.

NOTES ON ENGINEERING,

IV.

ON THE STRENGTH AND FORM OF THE MENAI TUBULAR BRIDGE.

The plan devised by Mr. R. Stephenson for a railway bridge consisting of a wrought iron tube 450 feet long, is so bold in itself, and suggests such very important and instructive lessons respecting the theory of girders, that an investigation of the principles on which it is proposed to construct the Menai Bridge, and of the form which it will be necessary to give it, in order that its strength may be uniform in every part, cannot fail to be interesting.

Before entering, however, on the investigation of this particular case, it may be as well to notice briefly the views of those eminent philosophers who have undertaken to investigate theoretically the strength of beams. We find here as in every other branch of the physical sciences, that the labours of each succeeding investigator have tended to define and simplify the opinions of his predecessors; and it is not only very interesting, but very useful to trace historically these modifications, because by considering the difficulties that have had to be overcome before fixed principles could be established, we are led to see the essential nature of the principles themselves.

The first philosopher who endeavoured to determine the laws regulating the strength of bodies acted upon by transverse strains was Gallileo. The chief error of his theory was that he assumed that when a body was about to break by an excessive pressure, all the parts near the fracture are in a state of tension. Another of his suppositions was that the tension of all the parts of the section of fracture was the same. This second error was in part avoided by Leibnitz, the next writer on the subject; he assumed that the tension of the beam deflected by a pressure varies as the distance of the particles from the concave side of the beam; he however adopted the first mistake of Gallileo, namely, that the particles of the deflected beam were all in a state of tension. James Bernoulli seems to have been the first to whom it occurred that the particles of the beam exerted different kinds of action on different sides of it, that the convex side was extended and the concave compressed, and that consequently on the one side the strains were of the nature of *tensions*, and on the other of *pressures*. The simple deduction from this view of the case was that there is some place between the two sides of the beam where the extension of the particles ceases, and the compression begins,—that is, there is a line in the beam which is neither lengthened nor diminished in length by the deflection. To this line Bernoulli gave the name of the NEUTRAL LINE: his views are now exclusively adopted; the only difficulty still existing refers not to their accuracy, but the means of applying them.

A very simple illustration of the fact that a deflected beam is partly compressed and partly extended, may be obtained by bending a twig of hazel or willow; if the bark be tender and flexible, it will be found to have a corrugated appearance—to be gathered up in folds—on the concave side, and on the convex side to be tightly stretched or actually burst asunder.

The chief difficulty in the above familiar instance, and one which indeed Bernoulli's theory is generally subject to, is the determination of the precise place where the material is neither stretched or compressed. But there is also another objection which will frequently hold—Bernoulli adopted so much of Leibnitz's theory as assumed that the tension of any part of the beam varied as the distance of a fixed line—that line being according to Leibnitz in the upper or lower surface—according to Bernoulli the *neutral line* between the two surfaces. Bernouilli's law of the molecular forces was in fact this, that if at any part of the beam, a plane be drawn perpendicular to the neutral lines, the elastic forces perpendicular to that plane (whether of the nature of pressures or tensions) are proportional to the distances of the molecules from the neutral line. This law was founded on Hooke's principle that the restitutive forces of a body are proportional to the amount by which its natural length is increased or diminished. But it is found in practice that it is possible to apply so great a strain to a body that Hooke's law ceases to be true; in other words, that there is a degree beyond which if the extension or compression of a body be carried, its restitutive powers will no longer continue to increase with the strain, but will actually diminish. The point is called the "elastic limit;" the nature of it may be illustrated by bending a flexible strip of metal or wood to such an extent that the restitutive forces are no longer able to restore the original form of the body, which remains permanently bent.

The difficulty certainly is often opposed to the application of Bernoulli's laws, because it is a matter of common experience that beams may be so much strained and bent as to permanently retain their deflection when the load is removed.

The most celebrated of the modern writers on the theory of the strength of girders are M. Poncelet and Prof. Moseley. The elaborate researches of the latter contained in the fifth part of the *Mechanical Principles of Engineering*, are well known to the English reader. In these researches however, the weight of the girder itself is neglected as small compared with the load to be supported: but as in the case of the Menai bridge, a great proportion of the strength of the material is required to support its own weight, a separate investigation seem to be required.

Distinctions between girders, arches, and suspension bridges.

It is very necessary that the effect on girders by which the molecular action on their upper and lower sides have opposite tendencies should be clearly conceived in the mind: for it is this opposite tendency which constitutes the essential strength of girders. It is also their *characteristic*, by which they are distinguished from the other structures for supporting loads between piers or abutments. In the *arch* the material is entirely in a state of compression, in the *suspension bridge*, of tension—in the *girder* alone part of the material resists compression, and part resists extension. Did not this property exist, the girder must, like the arch, and the suspension chain be more and more stretched, the more nearly it was horizontal. It is known that no finite tension will make a suspension chain quite horizontal, and that when the deflection is small the strain and tendency to rupture is very great. In the arch also it is known that where the curvature is small, the lateral thrust is greatly increased, and that when the height of the arch is very great compared with its span, the strain on the material is not much more than that of the superincumbent mass. In the girder, however, it is found that no advantage is gained by giving the surfaces a great curvature; the strongest and most useful form which can be devised is that for which the girder is equally strong in every part, and for the attainment of this object, the curvilinear surfaces of the girder may be made very much flatter than would be the curves of an arch or suspension chain, subjected to equal strain under similar circumstances.

Another important characteristic of the girder, due to the opposite tendency of the molecular action on its upper and lower sides, is that unless it be positively bent by its load, it exerts no lateral force on its abutments. A beam supported on two props will exert upon them a vertical pressure only, and however much it may be loaded will exert no horizontal force at its extremities unless the load be sufficient to alter its geometrical form. In an arch or suspension-chain, however, the smallest load requires a corresponding lateral force, this force being in the former of the nature of a thrust, in the latter of a tension. The distinguishing property of a girder in this respect is due as has been said to the *antagonism* of its molecular actions, for it is demonstrable that whatever lateral forces its particles exert on the lower side are counterbalanced by equal and opposite forces on the upper side, so that ultimately the resultant horizontal force is zero.

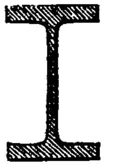
Form of section of greatest strength.

Before proceeding to determine the amount of the strains actually exerted in the proposed Menai tubular bridge, it is necessary to consider what form of the *transverse section* of the girder gives the greatest strength. These considerations cannot be expressed more clearly than in the following quotation from the fifth part of Professor Moseley's work already referred to. The extract deserves careful perusal, as the correct comprehension of it will clear up all difficulties as to the means by which the strength of girders is obtained:—

"Since the extension and the compression of the material are the greatest at those points which are most distant from the neutral axes of the section, it is evident that the material cannot be in the state bordering upon rupture at every point of the section at the same instant, unless all the material of the compressed side be collected at the *same distance* from the neutral axis, and likewise all the material of the extended side, or unless the material of the extended side and the material of the compressed side be respectively collected into two geometrical lines parallel to the neutral axis; a distribution manifestly impossible, since it would produce an entire separation of the two sides of the beam.

"The nearest practicable approach to this form of section is that represented in the accompanying figure (fig. 1), where the material is shown collected in two thin but wide flanges, but united by a narrow rib.

Fig. 1.



That which constitutes the strength of the beam being the resistance of its material to compression on the one side of its neutral axis, and its resistance to extension on the other side, it is evidently a second condition of the strongest form of any given section that when the beam is about to break across that section by extension on the one side, it may be about to break by compression on the other. So long, therefore, as the distribution of the material is not such as that the compressed and extended sides would yield together, the strongest form of section is not attained. Hence it is apparent that the strongest form of the section collects the greater quantity of the material on the compressed or the extended side of the beam, according as the resistance of the material to compression or to extension is the less. Where the material of the beam is cast iron, whose resistance to extension is greatly less than its resistance to compression, it is evident that the greater portion of the material must be collected on the extended side.

"Thus then it follows, from the preceding condition and this, that the strongest form of section in a cast iron beam is that by which the material is collected into two unequal flanges joined by a rib, the greater flange being on the extended side; and the proportion of this inequality of the flange being just such as to make up for the inequality of the resistances of the material to rupture by extension and compression respectively.

"Mr. Hodgkinson, to whom this suggestion is due, has directed a series of experiments to the determination of that proportion of the flanges by which the strongest form of section is obtained."

Effect of the vertical ribs.

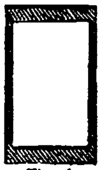


Fig. 2.

Now it will be seen from the representation of the transverse section (fig. 2) of the Tubular Bridge that it is in fact a girder of the required form, except in that it has two lateral ribs instead of one central rib. These ribs, it will be seen from the quotation, contribute to the strength of the girder, not so much *directly* by their own strength, as *indirectly* (1) by separating the upper and lower flanges, and (2) by establishing that rigid connection by which the opposite tendency of the molecular action already spoken of is maintained. These two offices of the vertical ribs ought to be rightly understood. Respecting the first, it may be observed that for a given quantity of material, the strength of the beam increases with the distance by which the upper and lower flanges are separated. This increase of strength does not arise from the increased mass of the rib, so much as from the circumstance that the further the flanges are apart, the further are they from the neutral line within the girder, and, consequently, the *greater is the leverage of the molecular forces*. The advantages of making the molecular forces act at a great distance from the neutral is illustrated in a very striking way in the floor-joists of a house, which are uniformly laid on their thinnest edges, in order that their upper and lower surfaces may be separated by the greatest possible interval. Again, if a flat slip of wood, such as a flat drawing rule, be pressed on its broad side, there is no difficulty in bending it; if, however, it be pressed on its thin edge it will be almost impossible to produce a deflection. Now, it is carefully to be noted that in both experiments the nature of the forces called into action are precisely the same; the material remaining unchanged, of course the cohesion or elastic force is unchanged also; the only difference is that, in the second case it acts with much greater advantage than in the first, simply because its leverage is increased.

It is but a very slight extension of this idea to conclude, that the form of the greatest possible strength is that in which all the elastic force acts at the greatest possible distance from the neutral line, or in which all the material is collected in the upper and lower flanges, except what is absolutely necessary for the due connection of them by the rib or ribs.

This brings us to consider the second office of the rib—the establishing a rigid connection between the flanges. It is not sufficient that the flanges should merely be *kept asunder*: for this purpose an open railing of vertical bars would be sufficient. But it is easy to see that if such a contrivance were substituted for the solid rib, the "antagonism" of the molecular forces would not be maintained. It is absolutely necessary that the upper and lower flanges should be in opposite states of elasticity and that they should mutually *counteract* each other. These requisites cannot be answered unless the web be rigid—not only vertically, to prevent the flanges approaching each other, but also laterally, so as to act in every part as a *rigid lever*, of which the fulcrum is in the neutral line, the molecular actions of the flanges constitute the balanced forces.

Before concluding these preliminary remarks, it may be as well to notice one passage from Mr. Stephenson's Report, published in the last number of this Journal. He says—

"Another instructive lesson which the experiments have disclosed is, that the rectangular tube is by far the strongest: that the circular and elliptical should be discarded altogether."

It may, however, be fairly asked, whether it were necessary to make that a matter of *experiment* which might be unhesitatingly predicted by the ordinary laws of mechanics? It is clear that, comparing a curvilinear and a rectangular tube of given depth and containing a given quantity of material, the latter is that in which the greatest proportion of the material has the maximum leverage, and consequently that the rectangular form is that of the greatest strength.

1. *Practical Limits to the length of the Girder.*

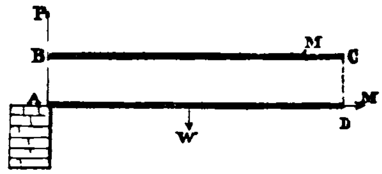
It will be found in the following methods of calculation that the particular form of the transverse section adopted by Mr. Stephenson, affords peculiar facilities for the determination of each problem without incurring the difficulties which are usually opposed to the application of the theory adopted by Bernoulli. It will be assumed in all that follows that the ribs are only sufficiently strong to bear their own weight, and to maintain the necessary rigid connection between the upper and lower flanges—that is that the whole of the available strength of the material is applied where it may have the most useful effect. It will remain to show hereafter how the flanges may be made to satisfy this assumption, or how far they will modify it.

It is proposed for the Menai Bridge that the plates of iron shall be one inch thick; this construction very nearly satisfies the conditions of the greatest strength as laid down in the extract from Moseley's Engineering given above. The first problem which will be the determination of the greatest possible length of a girder of the depth proposed (30 feet) so that it may bear its own weight.

It is found by experiment that wrought iron will bear with safety a strain of nine tons to the square inch, and if that amount be much exceeded, the material begins to stretch. Now as the beam cannot be deflected without some part of its material stretching, the point to be determined is this—what is the length of the beam when by its own weight a strain of nine tons to the square inch, is applied to the metal. It is obvious that if the beam be of uniform depth, the longitudinal strains will be greatest in the middle.

Let A B C D, fig. 3, represent a longitudinal section of one-half the girder, which is supposed to be cut in half by a vertical plane at C D. If we suppose the half beam to be acted upon at C D, by forces similar to the

Fig. 3.



molecular actions which actually exist at C D in the undivided beam, it is clear that the conditions of equilibrium will not be affected.

The forces acting on A B C D are—1st, P the upward pressure of the abutment (the beam being supposed uniform P = ½ the weight of the beam, by the ordinary conditions of equilibrium). 2nd, a downward force W equal to the weight of A B C D, and acting at the centre of gravity half way between A and D. 3rd, the molecular actions at C D.

Respecting these molecular actions it is to be observed that they are wholly horizontal; for P and W being both equal to half the weight of the beam P = W, and therefore if a third vertical force were introduced the equation of vertical forces could not hold. The molecular forces are therefore horizontal; they are also equal and opposite, for otherwise the equation of horizontal forces could not hold. As therefore we have supposed the plates A C, B D to be of comparatively small thickness, we may suppose the molecular actions to be represented by two forces M, M, in the directions indicated by the arrow heads. The only effect of representing all the forces of compression by one single force, and all the forces of tension by another single force, is the assumption of that which is practically true, that all parts of the section C exert equal pressures, and all parts of the section D equal tension, and that all the forces at C and at D, act so near each other that they may in each case be represented by a single force.

Taking moments about B, W ½ A D = M. A B. (1.)

Now we suppose the tension at D to be 9 tons or 20,160 lb. to the square inch; consequently if we call the area of the section D, a inches, M = 20,160 a.

W is the weight of the plates B C and A D: if the length of each of them be l inches, its solid content is $a\,l$ cubic inches, and since the weight of a cubic inch of wrought iron is about ·28 of a lb. the weight of each plate is $a\,l \times {\cdot}28$, and W is double this or $2\,a\,l \times {\cdot}28$. Substituting in (1.)

$$a\,l\,\text{A D} \times {\cdot}28 = 20{,}160\,a\,\text{A B} \qquad (2.)$$

$$l^2 = \frac{20160}{{\cdot}28}\,\text{A B} = 72{,}000\ \text{A B}.$$

A B the depth of the girder is in the proposed bridge 30 feet or 360 inches. Therefore multiplying 360 by 72,000, and extracting the square root, we get the value of l in inches: this value will be found equivalent to 424·26 feet. Hence we arrive at the following conclusion, l being half the length of the girder;

The greatest length of a girder 30 feet deep, which will support its own weight safely is 848 feet.

It will be observed that this conclusion is independent of the arch of the cross sections C and D, or of the width of the girder. This circumstance arises from the tension and weight being both proportional to the cross section.

2. *Tension at the centre of a Girder 450 feet long.*

The length proposed by Mr. Stephenson falls far within the limits of length determined by the last proposition. The next point to determine is the actual tension per square inch when the length is that of the Menai Bridge—namely, 450 feet.

Using the figure and notation of the last proposition we have putting in 2), the value of l or A C = 225 feet (= 2700 inches), and the value of A B = 360 inches; and putting also t for the tension per inch at D.

$$a \times (2700)^2 \times {\cdot}28 = t\,a\,360,$$

$$t = \frac{7{,}290{,}000 \times {\cdot}28}{360}$$

Effecting the operations indicated by this equation, we find the value of t to be 5670 lb., or 2·53 tons. Hence we come to this conclusion—

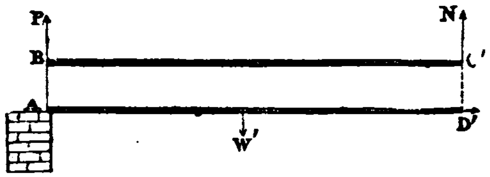
When the girder is 450 feet long the tension produced at its centre by its weight is rather more than 2½ tons to the square inch.

This conclusion like the last is independent of the area of the section C or D.

3. *Vertical strain on any part of the Girder.*

It has been demonstrated in the first proposition that the molecular actions are entirely horizontal at the *centre* of the girder; this however is not the case at any other part of it. We shall find that if a section be supposed to be made at any point but the centre, that the molecular actions have to be replaced by a vertical strain in addition to the horizontal couple of tension and pressure, and it will be found also that this vertical strain increases continuously from the centre to the extremities of the girder, while the horizontal couple on the contrary is greatest at the centre and zero at the extremities. The effect of this vertical strain, if it were sufficient to produce rupture, would be—not to tear the material *asunder*—but to make the particles at the surfaces of the section *glide* upon each other. It may be shown however that the vertical strain is so small that this effect need not be apprehended, and in fact may be neglected without appreciable error.

Fig. 4.



Let A B C' D', fig. 4, represent the longitudinal section of a larger portion than half the beam, the vertical line C' D' being now beyond the middle point. Let W' be the weight of A B C' D', and let N be the sum of the vertical strains acting at C' and D'. Then we have for the equation of vertical forces—

$$W' = P + N.$$

But the value of P is the same as in fig. 3, and is of course unaltered by the vertical section being removed to C' D'; that is, the value of P is, as before, W or half the weight of the girder. Hence

$$N = W' - W.$$

That is, the vertical strain is the difference between the weight of the portion of the beam on which it acts and the weight of half the beam. From the last equation it is clear that N increases as W' increases, and if the section be taken close to the further extremity of the beam where W' is nearly equal to the weight of the whole beam, N will be equal to 2 W – W, or half the weight of the beam. Giving N this its greatest value we may readily ascertain the strain which it produces per square inch of the vertical section. Taking as before the area of the section C' or D' to be a inches, and therefore of the two together $2a$, and putting v for the vertical strain per square inch, $N = 2\,a\,v$. Also the solid content of the two plates together is $2a$ multiplied by the length 5400 in. (450 feet), and since the weight of the cubic inch of iron is ·28 lb., the total weight of the two plates is $2\,a \times 5400 \times \cdot28$. Hence since N equals half this weight;

$$2\,a\,v = a \times 5400 \times \cdot28.$$

It will be found from this equation that the value of v is 756 lb., or *the greatest vertical strain per square inch is rather more than one-third of a ton.*

It is clear that this strain would have so small an effect to produce rupture that it may safely be neglected.

4. *Tension produced in the Girder by a given load.*

It has been shown that the greatest strain produced in the girder by its weight merely is rather more than 2½ tons to the square inch: so that if 9 tons to the square inch be taken to be the degree of strain which may safely be applied to the material, we have rather less than 6½ tons to the square inch, which may be produced by the railway train or other load upon the bridge. It is clear that when the load is at the centre it has the greatest effect or moment about the points of support at the extremities. Let us now examine what strain a given load would of itself produce at the centre neglecting the weight of the girder. Recurring to fig. 3, let us suppose the force marked W no longer to exist, and that at the point D a force w, equal to weight of the given load is applied. Let the force marked M now represent the strain produced by w. Also let P instead of its former value take the value now required, namely, $\frac{1}{2}w$: then it will be clear by reasoning similar to that in Prop. 1, that no *vertical* force but w acts at D. Taking moments about C, and putting $P = \frac{1}{2}w$,

$$\tfrac{1}{2}w \,.\, A\,D = M \,.\, C\,D.$$

A D and C B are in the proportion of 225 feet : 30 feet, or 15 : 2, so that we may substitute for the above equation;

$$M = \tfrac{15}{4}\,w.$$

Hence whatever number of tons w may weigh, the strain produced by w will be 3¾ times as many tons. To find the number of tons strain per *square inch of the vertical section*, we observe that the width of the plate is supposed to be 15 feet or 180 inches, and its thickness one inch, so that the area of the section is 180 square inches, and consequently the strain per inch is the 180th part of M. Consequently the strain per inch is equal to

$$\frac{15}{4 \times 180}\,w = \frac{15}{720}\,w = \frac{1}{48}\,w \qquad (3.)$$

From this equation we get the following simple rule—

For every 48 tons load acting at the centre of the bridge a strain of 1 *ton per square is produced on the metal plates.*

It follows from this that since after deducting the strain produced by the weight of the bridge an additional strain of rather less than 6½ tons per inch may safely be produced by the load, *the load which could safely be applied at the centre of the bridge is rather less than three hundred and twelve tons.*

In Mr. Stephenson's report it is calculated that the bridge can bear a load of 747 tons at its centre. But this discrepancy may easily be accounted for, by supposing that Mr. Hodgkinson's experiments had reference to the *breaking weight*, whereas here the load calculated is that which with the weight of the bridge would produce a strain of 9 tons to the square inch. It is to be observed also that in the present calculation the amount of the extreme load is somewhat underrated, because it is supposed to act at a single point, whereas in the case of a railway train it would be distributed over a considerable portion of the length of the bridge, and consequently when the train was at the centre of the bridge, the part of the load cut off by the vertical section C D, and resting on A D, would not act wholly at D, but the centre of gravity of this portion of the train would be applied at a point somewhat nearer the extremity, and the moment of the load would be proportionably smaller.

This however does not make a material difference. Mr. Stephenson says in his report that for practical purposes a strength equivalent to 747 tons in the centre would be insufficient; it is clear therefore that as 312 tons (which is less than half this load) causes a strain of 9 tons to the inch when the dimensions of the bridge are those here assumed, it is necessary to determine other dimensions by which the strength may be increased. There are two ways of effecting this object—1st, by increasing the depth of the girder; 2nd, by increasing the area of the transverse section of the plates, (that is, by giving the plates greater width, or greater thickness, or both). There is indeed a third method of increasing the strength, namely, by increasing the dimensions of the vertical ribs beyond the degree of strength necessary for the rigid connection of the upper and lower plates, but this method is so unphilosophical and involves such a waste of material that it may fairly be excluded.

The examination of the means of obtaining the requisite degree of strength by increasing the thickness of the plates, and the depth of the tube shall be given in the next number of this Journal. It is proposed also to examine how the dimensions of the tube may be varied in different parts of it so that the strength may be uniform throughout, to examine the effects of expansion and contraction of the material by variations of temperature, the form of the vertical ribs so that they may be sufficiently strong to perform their office without adding to the strain on the flanges, and lastly, the effects of imbedding the ends of the tube in solid masonry.

It may be as well to say one or two words to prevent the purpose of these suggestions being misinterpreted. They are certainly not intended for the guidance or direction of the distinguished engineer who has planned the Menai tubular bridge, and whose scientific knowledge is fully adequate for the calculation of its dimensions; but to those who have not fully considered the principles of the strength of girders the present investigations may offer an instructive lesson, especially as the conclusions are derived not from gratuitous and dangerous hypotheses, but from the common fundamental principles of statical equilibrium.

H. C.

The syndicate of the Fitzwilliam Museum, Cambridge, have received from Mr. Cockerell designs for completing the hall and staircase of the new building, for parts of which Mr. Basevi had not left any settled designs. Working drawings and estimates were ordered to be prepared forthwith.

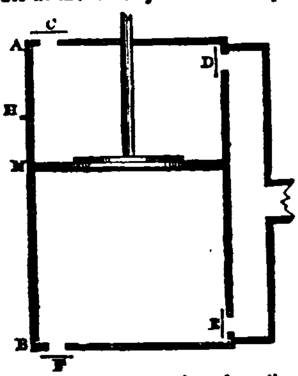
ON ATMOSPHERIC RAILWAYS.

Resistance from the Heat developed in the Air Pump.

By F. Bashforth, B.A., Fellow of St. John's College, Cambridge.

There are considerable differences between the mean theoretical and experimental resistances to the air pump piston, for given heights of the barometer, as stated in Mr. Stephenson's Report on the Atmospheric System. The discrepancies, for low heights of the barometer, are easily explained by a reference to the diagrams from which the numerical results were deduced. It here appears that the exit valve by its flapping through a very considerable space, caused an increased and useless resistance. In addition to this, it will be seen that at the very commencement of the stroke, the indicator frequently gave a pressure of nearly 1 lb. per square inch greater than the pressure in the tube. This no doubt was caused by the stream of air rushing into the cylinder in the same manner as water into the hydraulic ram. Thus the mass of air enclosed and expelled was greater than what was supposed by theory.

When the barometer rose to about 19 inches, although the above two disturbing causes diminish with the increased rarefaction in the tube, the differences of the theoretical and experimental results increased. This was so considerable that Mr. Stephenson was driven to suppose that in addition to the heat developed, a considerable leakage in the air pump existed. It appears, however, that the first cause is quite sufficient, and that the connecting tube must have admitted 206 cubic feet of air per minute at the density of the atmosphere. Let



$a = AB$ = length of stroke of air pump piston.

k = area of air pump piston.

Π = pressure of the atmosphere on a unit of surface.

$P_1 P_2 \ldots P_n$ the pressure of the air in the tube after $1, 2, \ldots n$ strokes.

$\rho_1 \rho_2 \ldots \rho_n$ the density of the air in the tube after $1, 2, \ldots n$ strokes.

V = volume of the receiver.

v = volume of the pump cylinder.

Suppose that at the nth stroke when the pump piston has described a space $BM = a - x$, that the density of the air is ρ and pressure P. Then

$$\frac{P}{P_{n-1}} = \left(\frac{\rho}{\rho_{n-1}}\right)^K \text{ (Miller's Hydrostatics (28.))}$$

Also $\rho V = \rho_1 (V+v)$.

$\rho_1 V = \rho_2 (V+v)$.

&c. = &c.

$\rho_{n-1} V = \rho_n (V+v)$.

$\rho V^n = \rho_n (V+v)^n$.

$\rho_n = \rho\left(\frac{V}{V+v}\right)^n = \rho R^n$, suppose

Also $P^n = \Pi R_n$, for the rarefaction of the air goes on slowly, and it is in contact with so large a surface of metal, that we may consider the temperature to be uniform, and $\therefore$ the pressure and density. The tendency however would be in favour of the atmospheric traction. $k a \rho_{n-1}$ = mass of air inclosed at the commencement of nth stroke $= k x \rho$.

$$\therefore \frac{a}{x} = \frac{\rho}{\rho_{n-1}}. \text{ Also } P = P_{n-1}\left(\frac{\rho}{\rho_{n-1}}\right)^K = \Pi R^{n-1}\left(\frac{a}{x}\right)^K,$$

when the exit valve opens $P = \Pi$, and suppose $x = \alpha$,

$$\text{then } 1 = R^{n-1}\left(\frac{a}{\alpha}\right)^K \text{ and } \frac{\alpha}{a} = \left(\frac{1}{R}\right)^{\frac{n-1}{K}}.$$

Work done in compressing the air =

$$\int_a^\alpha k P\, dx = \Pi R^{n-1} k \int_a^\alpha \left(\frac{a}{x}\right)^K dx = \frac{\Pi R^{n-1} \left(\frac{a}{\alpha} - 1\right)}{K-1}$$

$$= \frac{\Pi a k}{K-1}\left(R^{\frac{n-1}{x}} - R^{n-1}\right)$$

Work done in expelling the air $= \Pi k x = \Pi R^{\frac{n-1}{K}} a k$.

Work done by the assistance of the air in the tube

$$= \Pi R^{n-1} k \int_o^a \frac{V\, dx}{V + (a-x)\frac{v}{a}} = -\Pi R^{n-1} \frac{V}{v} a k \log_e R$$

Hence work done during the nth stroke,

$$= w_n = \Pi a k \left\{ R^{n-1} \frac{V}{v} \log_e R + \frac{1}{K-1}\left(K R^{\frac{n-1}{K}} - R^{n-1}\right)\right\}$$

Work done at the end of n strokes.

$$= W_n = \Pi \left\{ \frac{1-R^n}{1-R} \frac{V}{v} \log_e R + \frac{1}{K-1}\left(K \frac{1-R^{\frac{n}{K}}}{1-R^{\frac{1}{K}}} - \frac{1-R^n}{1-R}\right)\right\}$$

If w_n = a maximum, $\frac{d w_n}{d n} = o$.

This gives $n = 100$ nearly corresponding to a rarefaction of between 21 and 22 inches, which agrees exactly with experiment. If we do not allow for the heat developed, theory gives 19 inches.

STEPHENSON'S REPORT, TABLE NO. V.

Height of barometer.	Theory.	Difference.	Experiments.	Theory with heat.	Difference of Theory and Experimen
6	2·6	0·8	3·4	2·6	0·8
7	3·0	0·8	3·8	3·0	0·9
8	3·4	0·7	4·1	3·4	0·7
9	3·7	0·8	4·5	3·8	0·7
10	4·0	0·8	4·8	4·1	0·7
11	4·3	0·8	5·1	4·5	0·6
12	4·6	0·8	5·4	4·8	0·6
13	4·8	0·8	5.6	5·1	0·5
14	5·0	0·8	5·8	5·4	0·4
15	5·2	0·7	5·9	5·6	0·3
16	5·3	0·7	6·0	5·7	0·3
17	5·4	0 7	6·1	6·1	0·0
18	5·5	0·8	6·3	6·2	0·1
19	5·5	1·1	6·6	6·3	0·3
20	5·5	1·2	6·7	6·4	0·3
21	5·4	1·4	6·8	6·4	0·4
22	5·3	1·5	6·8	6·4	0·4
23	5·1	1·4	6·5	6·3	0·2
24	4 8	1·4	6·2	6·1	0·1
25	4·5	1·2	5·7	5·9	—0·2
26	4·0	0·9	4·9	5·5	—0·6
27	3·4	0·9	4·3	4·9	—0·6

The numbers found in Table V. of Mr. Stephenson's Report correspond to the valves of $\left(\frac{w_n}{ak}\right)$ for every inch of the barometer from 5 to 27 inches, where $\Pi = 15$ lb. and $K = 1·416$. The value found by comparing the theoretical and experimental velocities of sound. The accompanying table exhibits the theoretical and experimental values of the mean resistance to the piston.

In addition to the above test we may construct theoretical diagrams, and compare them with those found by experiment.

The equations to the part described before the exit valve opens

$$\text{is } y = h'\left(\frac{a'}{x}\right) \text{ when heat is neglected} \qquad (\alpha.)$$

$$\text{and } y = h\left(\frac{a'}{x}\right)^K \text{ in the other case} \qquad (\beta.)$$

where h' denotes the length of the line between 0 lb. and the dotted line in the figures representing the pressure of the air in the tube, and a' the length of the diagram. (α') evidently represents a series of rectangular hyperbolas referred to the same axes as asymptotes.

The curves (β) are found to agree very nearly with experiments, whilst (α, are very different when the height of the barometer is about 20 inches.

Both theories have their use. It has been seen that when heat is neglected the work done by the engine, and the useful effect may be considered equal. The other by its close agreement with experiment enables us to estimate the necessary loss of different arrangements on the supposition that the machinery is perfect.

Between 19 and 25 inches the loss arising from this source is 15 or 24 per cent. of the useful effect, and is another reason why the rarefaction in common instances ought not to be pushed beyond 18 or 19 inches.

UNFAITHFULNESS IN ARCHITECTURE.

By unfaithfulness in architecture we mean—the employment of forms or materials in such a manner that the true character of the architecture is disguised. This definition includes the use of materials deceptively, the application of architectural members to wrong purposes, the introduction of them when not used constructively, and lastly the decoration of the conspicuous parts of a building in such a manner that the eye is deceived as to the architectural character of the parts unseen.

A curious instance of unfaithfulness in architecture has recently been exhibited in some buildings connected with the Croydon Atmospheric Railway, in the employment of structures, resembling in form the turrets of Pointed Architecture, as *chimneys*. From these turrets may be seen issuing day by day dark volumes of smoke, and consequently all the upper portions of the ornamental work are blackened with soot. This begrimed specimen of mock architecture is of course so ridiculous that the most superficial observer can detect the absurdity of it: but it must be carefully noted that though in this case the accident of the discolouration has rendered the architectural error palpable, it is not that accident which *constitutes* the error—the principles of pure taste would have been quite as much violated even if the ridiculous appearance of the soot-covered mouldings had not rendered the violation manifest. At the same time we ought always to feel satisfaction when these accidents occur, because they render obvious to the most uneducated observers, the defects which otherwise would be condemned by those only who had studiously examined the principles of architectural taste. Though in fact we shall usually find that in all instances like these of the Gothic chimneys, some attendant disaster is sure to follow, which by a kind of architectural retribution—punishes the error by a signal publication of it.

To return however to the general subject, we may remark that one of the necessary consequences of architectural unfaithfulness is the neglect of what has been aptly termed *apparent construction*. This term (first introduced by Prof. Willis, we believe), signifies that development of the construction of a building by which it is made manifest how each part is supported, and in what manner each member contributes to the stability of the whole. It is not of course to be argued that wherever apparent construction is uniformly observed, the architecture is necessarily beautiful; because in that case we must be prepared to find beauty in a hut, a sty, or a stable; for in these structures the principles of apparent construction are generally observed for the sake of economy. But still the converse proposition may be safely asserted, namely, that where apparent construction is violated one of the sources of the beautiful is neglected; and it also seems an unavoidable conclusion that where forms which are individually beautiful are combined faithfully, the resultant must necessarily be beautiful also.

It is necessary that the exact value of faithfulness as an element of beauty should be thus clearly ascertained, because it is not uncommon to hear those who argue most zealously for the necessity making architecture faithful, speaking as if they thought that by securing to it this single merit, perfection was attained. For instance we find one of our contemporaries pronouncing the architecture of the Parthenon, faithful and *therefore* beautiful, whereas it is clear from the common instances which we have adduced, that faithfulness is separable from beauty—that it is but one element (though an essential one) of beauty, for we may readily conceive the possibility of architecture being faithful which is not beautiful, though it be quite impossible to imagine perfectly beautiful architecture which is not faithful.

We will take an instance, and perhaps our selection may appear a bold one, to illustrate our meaning. The dome of St. Paul's, notwithstanding the astonishing constructive skill which it displays is distinctly an example of neglect of the rules of apparent construction. The exterior dome instead of being supported entirely by the substructure, *as it appears to be*, is in fact carried by a timber framing resting on a cone of brickwork concealed between the inner and outer cupolas. On this cone of brickwork also rests the lanthern, which *apparently* is supported by the outer dome. Moreover the lateral thrust to the cone is resisted not by buttresses or other supports openly displayed, but by a hidden iron chain, which by its tenacity preserves the stability of the masonry.

If it appear very bold heterodoxy to adduce such an instance as this, we will bring the architect himself as a witness to corroborate our opinion. It will be remembered that the original design submitted by Sir Christopher Wren, for St. Paul's, was rejected. In this first design, of which a model exists in the present cathedral, "he endeavoured to gratify the taste of the connoisseurs and criticks with something coloss and beautiful, with a design antique and well studied, conformable to the best style of Greek and Roman architecture." Respecting this second design however—that ultimately adopted, we are told in the *Parentalia*, that he "then turned his thoughts to a cathedral form so altered as *to reconcile as near as possible the Gothic to a better manner of architecture*."—That is, he attempted an impossibility.

The character of St. Paul's, as has been recently stated by Professor Cockerell in his lectures, is (independently of the individual members) that of a Mediæval Cathedral. A cruciform building with a lofty central dome, it is obviously as different in form as it possibly can be, from the ancient classic models. And consequently in reconciling classic architecture to forms which it never contemplated, and for which it was not designed, it was necessary to import numerous contrivances which never belonged to the original style, and which therefore of necessity involved the violation of the principles of apparent construction.

To take another instance, and perhaps the most flagrant one in the same building,—who would imagine by inspection from the exterior, that the whole of the upper order round the church is nothing but a mask to conceal the flying buttresses behind it which are similar in purpose to those which in the ancient cathedrals are not only displayed openly, but are among the most beautiful features of the architecture. Of the hundreds who pass St. Paul's daily, how few are aware that the whole masonry which appears above the lower range of columns is an isolated mask, that it has nothing to do with the interior of the building, that it might be removed without producing the slightest change in the interior, that in fact it is merely an appendent excrescence answering no purpose whatever except that of concealment.*

It can scarcely be denied that the adaptation of classic architecture to the mediæval form involves incongruities and necessitates unfaithfulness of construction. The mere consideration that the characteristic of the one style is verticality, and of the other horizontality, seems sufficient proof that the two can never be successfully reconciled. In these particulars, namely—the predominance in the one of vertical, and in the other of horizontal lines—the two styles are not merely different but are diametrically opposed to each other. And it is clear that this antagonism is so direct, that it can never be avoided except by the violation of the principles of one or both kinds of architecture.

This truth has been laid down with sufficient distinctness by others than ourselves; but there is another great distinction between Christian and Classic Architecture, which though generally neglected is a most frequent cause of architectural unfaithfulness—Classic Architecture is characterized by UNITY—Christian Architecture by MULTIPLICITY. In the most perfect specimen of the Classic style, the Parthenon, the ground plan is the simplest possible, a rectangle, and all the details are combined so as to represent to the mind one single uncomplicated idea. In the most perfect specimen of the Mediæval style,—Cologne Cathedral, perhaps—the effects of awe and astonishment are produced by the combination of an infinite number of the most varied forms: the effects therefore in these two cases depend on entirely different principles. We endeavoured to explain this distinction in a former paper, by designating the one style as *statuesque*, that is, resembling a statue or sculptural group, in which every part contributes to the development of one single thought or action, and the other as *picturesque*, because it derives its beauty from the same various and complicated groupings which characterise the highest kind of painting.

If it be once admitted that Grecian and Christian Architecture are respectively distinguished by *unity* and *multiplicity*, it follows as a necessary consequence that an edifice in which the design as a whole is Mediæval, and the individual members Classic, must be incongruous. It would, we think, be scarcely denied that, were it necessary at the present day to build a new metropolitan church of the same importance as St. Paul's, notwithstanding the general admiration of the architecture of Sir Christopher Wren, the attempt to combine the cathedral form with the elements of Corinthian architecture would not be renewed.

Architectural criticism has frequently been censured for deficiency in fixed leading principles. Those whose office it is to pronounce on the

* That we may not appear singular in this criticism, we quote the following from the description of this church in Gwilt's Encyclopedia of Architecture. "We must here mention one of the most unpardonable defects or rather abuses which this church exhibits..... The enormous expense of the second or upper order all around the church was incurred for no other purpose than that of concealing the flying buttresses that are used to counteract the thrusts of the vaults of the nave, choir, and transepts—an abuse that admits of no apology. It is an architectural fraud."—B. I. ch. III. sect. 7.

merits of modern buildings are accused of forming their judgment on circumstances peculiar to each individual case, and not on broad general rules. The criterion however which we here advocate, that of faithfulness is certainly sufficiently general and definite. It were difficult to overrate the advance which modern architecture might make, were the necessity of using forms and materials faithfully once fully established in the minds of architects and critics. Even if such an obvious truth as this could be once firmly established—that a column when not used as a support, is simply a deformity—that the hoisting of a column on the first floor of a building, or the sticking it against the face of a wall, where instead of supporting the building it is supported by it—if only such plain lessons as these could be learned, we should have made a bold step towards the attainment of purity of taste.

Those who really love the art, and feel a generous zeal for its advancement, should devote their best energies to the development, and establishment of philosophical principles in it. It is a painful but unavoidable reflection, that while in most other professions the ability of the practitioner outruns the desires of the people, modern architecture scarcely ever satisfies their expectations. There is no difficulty however in assigning a sufficient reason for these deficiencies. Almost all other branches of modern skill exhibit a spirit of a philosophical accuracy which exactly accords with the intellectual genius of the age; in architecture alone we are still trammelled by obsolete forms, and instead of adopting the principles and emulating the excellence of the purest ancient architecture, continually reproduce the barbarous incongruities invented by our more immediate ancestors.

CHURCH ARCHITECTURE, AND CHRIST CHURCH, PLYMOUTH.

Only by the encounter of opinion with opinion is it that prejudice can be overcome, and truth elicited in matters of opinion, criticism and taste. Such encounter, however, cannot take place unless contrary, and conflicting opinions are brought forward in the same quarter, so that the same readers may learn what is said on both sides of the question; otherwise they get only one—perhaps the weaker half of the argument, which passes for being unanswerable, merely because it is unanswered, or not allowed to be answered, all that would make against the side which has been taken up, being studiously suppressed. Such convenient one-sidedness generally takes the plausible name of consistency, and it certainly flatters the indolence of those who having made up their minds upon any subject of inquiry, once for all, do not like to be disturbed and put to the trouble of reconsidering what they would fain believe to be incontrovertible. Yet even sound opinions are apt to grow rusty by time, and the advocacy of them to degenerate into mere dogmatism, if they be not occasionally stirred up and turned over afresh. This has been decidedly the case with regard to architectural opinion and criticism, in which browbeating assertion founded chiefly upon previous authorative *dicta*, has been substituted for convincement, whether in confirmation of or in opposition to such authorities; for nearly the same superstitious reverence for *precedent* which prevails in regard to architectural styles, prevails also in regard to architectural doctrines. Nevertheless, even doctrines that are sound in the main, require sometimes to be further explained, to be illustrated by positive example, and to be set in a fuller and clearer light; and it is owing to this act being done, that so far from being able to defend the traditional opinions and arguments which they have adopted at the outset of their studies, people feel bewildered when they find them impugned, and unable to defend them, though they may be obstinately determined not to give them up, or even admit any qualification of them.

Wherefore should not architectural criticism, instead of being confined to the narrow and beaten track in which it is now made to move—or rather hobble along just at the heels of precedent—a sort of *laquais de place* to it, and sometimes a Will-o'-the-Wisp,—why, I ask, should it not be allowed to range freely and exercise itself as it lists? It is time for us now to turn our attention to something more than the consideration of styles alone, and the mere settling of dates and matters of that kind, to which the study of the art as a branch of literature and criticism has hitherto been almost exclusively limited, the merely historical and antiquarian quite overwhelming the *æsthetic*; whereby such study has been rendered one that chiefly exercises the faculty of memory, leaving that of taste inactive, and inert. If in addition to the historical and non-architectural we obtain tolerably full matter-of-fact description, it is nearly the utmost that we ever do. Take our English Cathedrals—for they have been more frequently and more minutely spoken of than any other structures of the kind; which among them all has been made the subject of a complete critical and æsthetic examination, noticing every peculiarity in it? In other words, have we any *artistical* descriptions of them?—that sort of description which not only illustrates but *illuminates*, kindling up into beauty, irradiating and making clearly perceptible what is also hardly discernible to ordinary eyes?

No wonder, therefore, that persons in general hold architecture to be a dry study, and find it to be a distasteful one, encumbered with grave and learned pedantry on the one hand, and a dully plodding, and mere mechanical pursuit on the other; while as to the vaunted mystic excellence of 'proportions,' thanks to those who have systematized them, they are to be got at ready-made—for the matter of that so is criticism too, and the essence of it consists not in judging of buildings according to their intrinsic and individual merit as productions of architecture, but in *prejudging* them according to certain conventionalities, and wherever those are broken through, in condemning without further inquiry. Nearly the same one-sidedness which once scouted Gothic architecture altogether, as barbarous, prevails now, the difference being that it is in contrary direction, pushing veneration for it to superstition.

Cumbersome tediousness, amounting to nothing as architectural information, and bewildering unreadableness are the prevailing faults of most of the recent publications which profess to speak at length of our ancient architecture as exemplified in particular buildings. As to modern churches, though they obtain more frequent and a far greater share of notice than almost all the other classes of buildings put together, they are criticised only *Ecclesiologically*, or else cried up as wonders in newspaper paragraphs that read very much like paid-for newspaper puffs. Mr. Wightwick may, therefore, consider himself singularly fortunate, and his Christ Church at Plymouth especially favoured by the latter having been made the subject of remarks partaking of controversy; and as I myself think think it has been captiously censured for what I am inclined to look upon as an improvement rather than the contrary, in modern church architecture,—at least where galleries are introduced, I avail myself of the opportunity arising out of what has been said to offer some further observations. Besides that, I honour Mr. Wightwick for being one of the few of the profession who think for themselves, without waiting to be prompted by precedent on every occasion. Candidus owes him some reparation for having published, some time ago, a paper in one of the leading periodicals, entitled "Wightwickism," intended to be commendatory, but which some dull matter-of-fact blockhead in a Plymouth newspaper pronounced to be nothing less than a complete cut-up!—whereas, had that been my object, I should have exhibited my ability in cutting-up after a very different fashion. Perhaps, for the benefit of the country gentlemen, that is, country newspaper editors, I ought to give warning that I am not going to cut-up Wightwick now; *tout au contraire*, to give him my good word—and it may go for just as much as that of many others.

In his reply to the strictures upon his church at Plymouth, Mr. Wightwick asks if it be "quite fair to call the only front that shows a *show front*." Most certainly not, if that term is to be taken, as was evidently meant in an injurious and reproachful sense; and if not so intended, it is only an Anglicised version of the Italian '*faciata*,' and our naturalized Anglo-Italian word '*façade*.' As a term of a reproach in contradistinction to 'façade,' that of 'show-front' applies only where the other sides of a building are seen, yet are quite out of keeping with the display affected in the principal one. The British Museum, for instance, will have a veritable show-front, and even that front will be in some measure disfigured by the paltry buildings which are allowed to come into sight between the main body of the edifice and the west wing. It will be said by some that a church *ought* to stand quite apart from other buildings, so as to show more than a mere façade towards the street: yet such 'ought' is not very evident, it depending in a great measure upon circumstances, and even where there is nothing to prevent a church from being quite insulated; that may be rather a disadvantage than not in regard to architectural design, because if the funds are limited, either architectural finish will be confined almost exclusively to the west or entrance end of the building, which therefore becomes a mere show-front, or such inconsistency is avoided only by impoverishing that and making the whole exterior equally poor and insipid throughout. One or other of these flagrant defects is exemplified in most of our modern structures, whatever merit some of them may possess in other respects; and one of the latest of those erected in the metropolis, which shows very well from one point of view, looks almost ludicrously mean, owing to the body of the church being fully exposed to view on the north side, it being a mere pigmy in comparison with the tower and spire, at the foot of which it seems to have squatted down.

After all, 'show front,' perhaps, might pass, were it not for something much worse, the unpardonable *peché mortel* of Mr. Wightwick's church being that it is lighted on the sides only by clerestory windows, there being none in the aisles. This is found fault with as *unchurch-like*,—and if by 'unchurch-like' were meant nothing more than that it differs from what we are accustomed to see in churches, the epithet would be suitable enough; but it implies a very great deal more—nothing less than something unbecoming to, and what ought on no account to be adopted for churches. Yet why not?—more especially if situation requires it, when such mode of obtaining sufficiency of light in spite of the external obstructions occasioned by surrounding buildings, ought to be prized as a great advantage in itself and one immediately derived from the Gothic style, and in effect characteristic of ecclesiastical examples of it. Were it found that an interior having no other side windows than clerestory ones, can be but imperfectly lighted, the objection might be considered tolerably valid; but such certainly does not appear to be the case in regard to Christ Church, because in the extract given from the Plymouth Journal it is spoken of as being "cheerful as the day," though that may be only a flourish of newspaper rhetoric. Be that as it may, we need not travel to Plymouth to ascertain whether it be possible for a church so circumstanced in regard to windows to be adequately lighted, because there happens to be one now erecting, and fast advancing to completion, near Fitzroy-square, which instances every one of the points that are deemed architectural heresies and deviations from orthodox ecclesiology in Mr. Wightwick's structure, it being built in between houses, consequently having only a show-front, and being lighted on its sides by clerestory windows only. In regard to the Plymouth structure, it has been assumed somewhat confidently that it must be either insufficiently lighted, or the clerestory windows so enlarged as to become "very prominent features"—of course disadvantageously so. Excess of size in its clerestory windows is certainly not the fault of the other church just alluded to, for there they consist of very small apertures put in pairs over each arch of the aisles; yet so far from there being any deficiency of light, there seems to be rather too much, and that it requires to be moderated by diapered glass, notwithstanding that at present one of the end windows is covered up by temporary boarding before it. Little, indeed, can be said in favour of the interior itself, since it is bare and poor, but its unsatisfactoriness is certainly not occasioned by there being no windows in the aisles, since were there any, the effect would be rather for the worse than the contrary.

"We never should expect," it is urged in argument against Mr. Wightwick's building, "to meet with an ordinary *skylight* in an ancient church," which remark, as far as it has any drift at all, seems to imply that such is, nevertheless, the case in his modern one, although to answer to the name of skylight at all, his clerestory must be a very *extraordinary* skylight indeed. That the exclusive employment of clerestory windows, or in other words, of windows placed aloft, so that light streams down into the building, is contrary to the spirit of pointed architecture, is more easily asserted than to be borne out by proof. The effect so produced is certainly a peculiar and unusual one, but it has generally been prized accordingly as of rare merit. This it is which if it does not constitute, contributes so greatly to the peculiar and charming effect of the octagon in Ely Cathedral. To say that and similar instances do not answer to the title of "clerestory would be only cavilling about words, because the point for actual consideration is, not whether such term can be correctly applied to instances of the kind, but whether such mode of lighting a Gothic interior principally, if not entirely, from the upper part of its sides, be contrary to the spirit of the style itself or not; or if not exactly that, be "un-church-like." That it must inevitably be the latter, and that the character of an interior so lighted must partake of that of an exhibition-room or picture-gallery has been decisively taken for granted, else why should the National Gallery be referred to as proving most convincingly that the effect attending light admitted from above must be "essentially secular." Why! except that single circumstance, there is not a single particular of resemblance, and even in regard to that there is a difference, the rooms alluded to being lighted by *sky-lights* or lanterns in the ceilings. Undoubtedly the light is there generally diffused, because it was intended to be so, neither is there any decided architectural expression or any play of light and shade, there being nothing whatever to produce either the one or the other. Does it follow that every other interior into which the light is admitted at all after the same manner as in a picture-gallery or museum, must on that account resemble an apartment of the kind? Can no differences as to style, as to design, as to arrangement, as to fitting up, as to quantity of light, &c., overcome such fatal resemblance to a secular building?

Had it been intended to judge fairly what striking architectural expression and effect may be achieved almost entirely by admitting light from above, a very secular building indeed—namely the Bank of England, might have been referred to as exhibiting a variety of modes and ideas of the kind, all of them attended with differences of effect. There might even have been policy in especially pointing to the halls and offices in the Bank, as that would have furnished a very plausible protest against the unseemliness, if not actual profaneness, of adopting for religious buildings an arrangement in regard to lighting, that could by any possibility be likened to one desecrated by having been made use of in a temple of mammon.

It is amusing to observe how readily people allow themselves to be scared by bugbear words and mere names, 'secularity' is one of them, as if everything in and about a church ought to be totally distinct from, and bear no sort of resemblance whatever to anything else of the same kind employed in buildings of a different character. If such ought to be the case, we ought to be informed *how* it is to be accomplished. Some of the leaven of secularity is freely enough tolerated in churches without scandalizing even the most scrupulous,—coats of arms, for instance, monuments with fulsome epitaphs, and other mundane varieties. Rooms with either lantern lights, or with windows only overhead in the upper part of their walls, are not so exceedingly common that such mode of lighting can be regarded as secular and unchurchlike on that account. And if there be anything at all in symbolism, *light from above*, proceeding immediately as it were from heaven, while all external objects reminding us of this every-day world are excluded from view, might surely be thought equally appropriate and significant in a church. It is not denied that side windows in the aisles are characteristic of our ancient churches, and if in modern ones they are made worthy features in themselves, and the character established by precedent can be fully kept up in all other respects, well and good; but where aisles serve only as recesses for seats and galleries, windows in them chiefly render the deviation from ancient precedent all the more offensive—in fact, a positive solecism, exactness being profusedly aimed at under circumstances which render it unattainable. If we can imitate with perfect consistency, with such thorough observance of former architectural *costume*, and with such *deceptive* fidelity that a modern structure can perfectly counterfeit an ancient one, correctness, though after all it amounts to no more than copying, may pass for a merit; but when altered circumstances require a different mode of treatment, it is for the architect to comply with the exigencies of circumstances without forfeiting any of the spirit of the style he adopts, but on the contrary to engraft upon it fresh ideas that may serve as precedent hereafter. Truly, it is not every one or any one that can do this; otherwise architecture would not deserve the name of ART. All the more honour therefore be to those who can.

CANDIDUS.

PARSEY'S AIR ENGINE.

The facility with which unprofessional observers are deceived respecting the value of mechanical inventions is really lamentable. The locomotive air engine is a case in point. This contrivance was described with an engraving in our last volume, p. 298, and we should have contented ourselves with the notice then given, without again alluding to the subject, but that we find this invention lauded in newspaper paragraphs as calculated to produce a revolution in the system of locomotion. To the scientific man the language of the paragraphs alluded to will suffice to prove that they are written by incompetent persons, but the general reader has not the same means of ascertaining the value of these encomiums. We wish to call attention to a notice which has been forwarded to us by a Dublin Correspondent. The object is briefly to show that for a journey of thirty miles there would be required 37,200 cylinders full of air, or as many *cubic feet*, if each cylinder full be a cubic foot, (a very low estimate); and that supposing this air ten times as much compressed in the reservoir as in the cylinder the capacity of the reservoir must be equal to one-tenth of the 37,200 cubic feet; that is, the magazine if eight feet diameter, would be required to be 75 feet long. Of course it would be preposterous to carry with the engine a vessel of this magnitude.

In the first place, no power is *gained* by using compressed air, because as much force must be employed in condensing the air into the receivers, as the condensed air can exert when brought into action. Next let us see what size of magazines or cases would be required for a railway locomotive worked with compressed air, for a thirty mile stage.

"The cylinders of a modern locomotive are about 14 inches diameter, that is, the pistons have each an area of about one foot; the stroke is usually about 16 to 18 inches, and the circumference of the driving wheels is about 17 feet; they will consequently make about 310 revolutions in a mile; the pressure in the pistons is about 50lb. on the inch. Then, assuming that the air is compressed to a pressure of about 5000 lb. on the inch, we have the elements for calculating what size of magazines or cases would be required."

"As the wheels would make $310 \times 30 = 9300$ revolutions in 30 miles, and as the two cylinders would each be filled twice during each revolution, there would be $9300 \times 4 = 37,200$ cylinders full of compressed air required to carry on a locomotive 30 miles! Assume that the air was worked expansively in the cylinders, and that only a cubic foot was admitted at each half stroke, the quantity of air compressed to 50 lb. on the inch, would be 37,200 cubic feet; but as the air is supposed to be compressed to 500 lb. on the inch in the portable magazine, its cubic contents would still require to be 3,720 cubic feet! To hold this would require a cylindrical magazine of about 8 feet diameter, and 75 feet long! Rather a bulky case to move about, or carry along a line."*

We have only one remark to make in support of these conclusions, and that is, that not only would there be no gain of power by the above arrangement, but many sources of absolute loss. In the first place there would be the friction of the engine pumping the air into the magazine, and in addition the friction of the locomotive engine worked by the compressed air. So that comparing Mr. Parsey's system with the present locomotive system, there would be for every journey the friction of two engines instead of one. Another source of loss would arise from the fact that all elastic fluids when compressed develop their latent heat. Now as the elasticity of air is greatly increased by an increase of heat, it is clear that the development of latent heat would in the present case greatly increase the labour of pumping. This increased elasticity by the generation of heat would however be all *lost*, for the magazine would be rapidly cooled by the radiation of its metallic surface. Another loss would arise from the *refrigeration* of the air by its dilation when passing from the magazine to the cylinder.

It may be said that air could be pumped into the magazine so slowly that the development of heat would not be apparent to the senses. But this is only concealing the evil instead of removing it. It is true that the heat might be generated so slowly that the radiation of the cylinder would carry it off as fast as it was produced, but this would simply render the evil *non apparent*.

Contrasted with the previous quotation which avoids all difficulties arising from the variation of the pressure in the reservoir, we have a letter addressed to the *Mining Journal* in favour of the new invention. We wish to draw attention to one error in it, because it is one very likely to be committed by a person not familiar with the theory of pneumatics, and as it entirely vitiates the calculations. The writer calculates "that to draw a train 60 miles with a tractive force of 3000 lb. the work done must be 1,188,000,000 lb. moved through one foot," and the letter concludes in the following manner.

"Let it be proposed, to compress the air to 1000 lb. pressure, which will give a medium working pressure of 500 lb. per square inch; 1000 lb. pressure per square inch is equal to 66 atmospheres—consequently, a column of air compressed into 66 times its density—*one* foot high, and 1 inch square at the base—will lift 500 lb. 66 feet high, or 33,000 lb. 1 foot high; consequently, a column of compressed air of 66 atmospheres, being 1 foot high, and 1 foot square at the base, will lift $33,000 \times 144$ lb. 1 foot high, or 4,752,000 lb. 1 foot high. Then, as 4,752,000 lb. will require one cubic foot, what will 1,118,000,000 lb. require?—Answer, 237 cubic feet. In like manner, if the air were compressed to 2000 lb., the contents of the magazine required would be 60 feet. A magazine of 3 feet diameter, 9 feet long, and 1 inch thick, would, therefore, be amply sufficient; the weight of such a magazine would be 4000 lb.—An Engineer: *London, Feb.* 18."

The chief error in the above paragraph is the assumption with which it starts, that if the air be at 1000 lb. pressure at the first, and at 15 lb. pressure at the last, the average pressure will be about half way between these two pressures, or equal to 500 lb. Now we want to show that the average will not be nearly so much as this, and the explanation is worth attending to, because it shows the danger of "jumping" at conclusions.

Suppose, for simplicity, the case taken in the extract, of the air in a tube 66 feet long, and of uniform diameter, being compressed so as to occupy only one foot of the tube at its end: what we want to find is the work done by this compressed air (or the number of pounds moved one foot by it), while being dilated back to its ordinary density. Tracing its progress foot by foot from the first foot to the sixty-sixth, we find that at the second foot it occupies twice as much space as at first, at the fourth foot, four times as much space, at the eighth, eight times as much, &c. Consequently the pressures at the 1st, 2nd, 4th, 8th, &c., feet are respectively 1000, 500, 250, 125, &c. Now the mere consideration that at the second foot the density is reduced to 500, shows how terribly the average has been overrated in the above extract, where the rapid decrease of pressure is neglected, and the air is supposed to act with the same average force throughout the 66 feet, which in fact it exerts only from the first to the second foot.

We could not without a few mathematical symbols calculate the exact amount of work done in the present case, still we can give an approximate method readily intelligible to any one acquainted with the first four rules of arithmetic. Let us consider what would be the pressure of the air at the first, second, fourth, eighth, &c. feet, and let us suppose that it passes from each one of these stages to the next without a diminution in pressure. This supposition of course exaggerates the amount of work done. Then from the first foot to the second it moves 1000 lb. through one foot; from the second foot to the fourth it moves the half of 1000 lb. through two feet (= 1000 lb. through one foot); from the fourth foot to the eighth it moves the fourth of 1000 lb. through four feet (= 1000 lb. through one foot, &c.) Arranging the results in the form of a table, we have—

			Work done or number of lb. moved one foot.
1st to 2nd foot,	1000 lb. through 1 foot	=	1000
2nd to 4th, half of	1000 lb. through 2 feet	=	1000
4th to 8th, quarter of	1000 lb. through 4 feet	=	1000
8th to 16th, one-eighth of	1000 lb. through 8 feet	=	1000
16th to 32nd, one-sixteenth of	1000 lb. through 16 feet	=	1000
32nd to 64th, one-thirty-second of	1000 lb. through 32 feet	=	1000

This gives the total work up to the 64th foot; for the remaining two feet add two sixty-fourths of 1000 lb. (about 31 lb.), and we find finally for the total work done, that according to the above calculation (which is a very favourable one) the number of lb. moved one foot is 6031. The "Engineer" makes the number 33,000, or more than five times as much!

The following method gives the true result much more accurately. If the pressure at a distance of 1 foot from the end of the tube be 1000 lb., at any increased distance x the pressure will be $\frac{1000}{x}$, and $\frac{100}{x}\,dx$ will be the work done through a short distance dx, $\therefore$ the whole work done will be $1000\int\frac{dx}{x}$ between limits 65 feet and 1 foot $= 1000 \times \log_e 66$ $= 1000 \times 4{\cdot}1896 = 4189{\cdot}6$.

The amount of work then really done is equivalent to 4189 lb. moved through one foot. Comparing this with the quantity calculated by the "Engineer," (namely, 33,000 lb.), we find that he has made it between *seven and eight times what it ought to be.*

It is really lamentable to see people deluding themselves and others in this manner. The newspapers state that Prince Albert saw the model of the air engine, and expressed his approval. It is not however stated that he made any calculations, or that his royal power extended to a suspension of the laws of elastic fluids.

We had almost forgotten to mention that the pressure in the reservoir supposed to be 1000 lb. to the square inch, is more than ten times as much as the very extreme pressure which is considered safe in the boiler of a locomotive engine.

Dredging Machinery for Egypt.—M. Cavé, of Paris, who contracted for the building of the Chaptal, iron steamer, with all her machinery complete, which is about leaving France, is now busily engaged at Rouen, in shipping off to Alexandria, in Egypt, the different materials to complete the large dredging machine, for which he has contracted with the Pacha, Mehemet-Ali, for the purpose of dredging the Nile, so as to render it perfectly navigable. This is only a preliminary step towards the cutting of a navigable ship canal across the Isthmus of Suez, to join the Red Sea with the Mediterranean—one of the grand projects of the Emperor Napoleon.

* Of course if the pressure be 1000 lb. to the inch in the reservoir, the size of it will be reduced one-half.

PRESSURE ON RETAINING WALLS.

In the first volume of the Transactions of the Institution of Civil Engineers, Ireland, is published a paper by Mr. Neville, on the horizontal resistance required to sustain banks of earth. The *formulæ* arrived at in this paper were printed at p. 242 of the last volume of our journal; and a letter having appeared at p. 359 of the same volume, subscribed "A Young Engineer," asking for a demonstration of the results given, Mr. Neville has been good enough to send us in reply a copy of his printed paper. Before, however, making any extracts from it, we wish to state an objection which appears to us to apply generally to the mechanical considerations on which the mathematical investigations are based. If, however, we mistake Mr. Neville's views, he will, of course, have the opportunity of replying.

The earth behind a revetement wall of a railway cutting pressing on every part of the masonry, the equations given by Mr. Neville determine *the resultant of all the* horizontal pressures, but the *moment* of this resultant the application are left undetermined. Now, the determination of the value of the resultant pressure, is not sufficient of itself for ascertaining the necessary strength of the retaining walls, or rather, that value, if it *alone* be determined, does not afford the slightest assistance whatever in examining the conditions of equilibrium. The case contemplated by Mr. Neville appears to be one which seldom if ever occurs in practice—namely, the moving of the revetement wall bodily forward without overturning. Whereas, in reality, the real points to be ascertained are the necessary thicknesses of masonry, to prevent, 1st, the slipping of the courses of bricks on each other; 2nd, the overturning the structure about its base.

In order to the ascertaining these two points, two sets of equations are required. The first set of equations must exhibit the variations in the degree of pressure on the revetement at different heights from the ground. It is manifest that the pressure will not be uniform, that it will generally be greater near the base than the top of the wall. Consequently, to prevent the courses of masonry slipping on each other, the "wall of equal strength" (that is, the wall in which the strength is everywhere proportionate to the pressure) will be of the greatest thickness at the base and diminish upwards. To ascertain the varying form of the wall the *law* of variation of the different pressures must be ascertained. Mr. Neville has, however, considered only one single pressure to be acting on the wall—namely, the resultant of all the pressures, which, in reality, exist.

The next point to be ascertained is the tendency to overthrow the wall by turning it about its base, to this end we must have equations exhibiting not the *value* of the pressures merely, but their *moment or leverage*. For it is clear that of two equal pressures acting on a wall, that which is applied at the greatest distance from the base will have the greatest *purchase* or effect to throw down the structure. To find therefore how strong the wall must be built to prevent its being overturned, it will be necessary either to ascertain the resultant force and *also* its point of application; or (if it be possible) we may determine the sum of the moments of the pressures on every point of the wall. In analytical language if p be the pressure on a unit of the area of the wall at a height x from the base, the quantity to be determined is $\int p\, x\, dx$.

The calculations of the paper before us would be perfectly satisfactory, if it were possible so to build the retaining wall that by means of it a pressure equal, and exactly opposite to the resultant of the pressures from the earth could act at the same point of application. This, however, is obviously impossible, for the horizontal resisting force exerted by the wall is applied at the base, since all the strength of the structure is derived ultimately from its connection or cohesion with its foundations. The resultant pressure of the earthwork is however applied at some point above the base; the two forces, that which sustains the wall, and that tending to overthrow it, cannot therefore be supposed to be applied at the same point. The determination of the value of the latter force, therefore, is not of itself of any value, for it may happen for instance to be applied at a distance of two feet from the base, or at a distance of four feet, and in the latter case its effect will be twice as great as in the former. It is not the pressure, but the momentum of it which is to be sought for, and without this be determined, no useful result can be deduced from the mathematical investigations.

Mr. Neville quotes in a note the concluding remarks of a paper on the resistance to banks of earth, by Tredgold, in the 51st volume of the "Philosophical Magazine," and adds "It is, however, evident that Tredgold was mistaken in this conclusion." If Mr. Neville will again refer to the original, he will, perhaps, see that the mistake is his own, and arises from a misapprehension of the sense intended to be conveyed. He might, by-the-bye, have taken a hint for his own investigation from Tredgold, who is careful to determine not the pressure only, but the moment of it.

OCEAN WAVES.

(We have slightly abridged this interesting paper from the "Nautical Magazine.")

Oceanic waves, from whatever source they may arise, have always been regarded as objects of interest to command our attention, yet very little is known of the laws whereby they are raised, augmented, or transferred. Landsmen, when actually embarked in stormy weather, are generally so deranged by sea-sickness and the ship's motion, as to be rendered unfit for observation or philosophical research. On the other hand, practical seamen, accustomed to the sea from an early age, although not altogether disqualified, become so familiar with all kinds of waves, that the subject is a matter of indifference to them.

It is, however, very certain that erroneous notions are entertained about waves, for we read in works of acknowledged merit, that the height of waves above the mean sea level, seldom exceeds six or eight feet, yet the language of poetry and metaphor raises them into aqueous mountains.

Some sense, and a good deal of nonsense about waves, was published by a section of the British Association for the advancement of Science. Being smitten with the mania of making *observations* on waves, and leaving Daddy Neptune to make the actual *experiments*, I seriously set to work at my official residence, which is within thirty feet of the Atlantic, and 3,800 miles from the nearest land on the north-east coast of South America; the waves, therefore, coming from the south-west have "a pretty considerable fetch." I had, perhaps, the best opportunity, and much inclination to collect as many facts as possible about the waves, that are almost constantly commanding my attention. I now send those I made at Plymouth, believing they may be useful; as nothing of the kind has ever been published, they afford data for mathematical research. The observations are arranged in a tabular form, with very brief remarks of my own, extracted from a paper of mine, where the subject is more fully discussed.

Observations made on Waves reaching Bovisand, east-end of Plymouth Breakwater.

No.	Date.	Dpth of Sea.	Dist. travelled by Wave.	Time of transit	Dist. from Wave to Wave.	Course of Wave.	Wind.	Barometer.	miles. per hour.	Altitude of wave.
	1841.	feet.	feet.	sec.	feet.					feet
1	Aug. 11.	46	2265	61	320	E.N.E.	N.N.W. st	29.65	21.9	8
2	Sept. 5.	48	2265	66	175	N.E.	N.E. light	„ 72	20.2	2½
3	„ 7.	46	2760	136	110½	N.EbN.	E. fresh.	„ 7	14.0	2½
4	„ 13.	48½	2760	64	345	N.E.	S.E.	„ 7	25,4	4
5	„ 14	49	2760	75	345	N.E.	S.E. strong	„ 7	23 4	4½
6	„ 28.	42	2760	6[illegible]	450	N.EbN.	S. b. W.	„ 36	26.5	
7	„ 28.	50	2760	60	460	N.EbN.	S.W. str.	„ 15	27.1	mid
8	„ *29.	45	2760	66	442	N.E.	N.N.W. m	„ 23	24.7	27
9	„ 30.	40	2760	67	408	N.E.	S.W.	„ 24	24.2	mod
10	Oct. 1.	47	2760	60	345	N.E.	N.E. light.	„ 57	27.1	low
11	„ 2.	45	2760	75	306	N.E.	calm	„ 7	21.7	long low
	1842.									
12	Jan. 14.	40	2760	72	394	N.EbN.	N.W.	„ 6	22.6	„
13	March 1.	49	2760	75	306	N.EbN.	N.W.	„ 2	21.3	„
14	April 29	48	2760	65	460	N.E.	E. b. N.	28.28	25.2	„

Remarks on the Observations.

No. 1.—San Carlos to Bovisand Rocks.
2.—This evening only ten waves over space.
3.—Distance traversed from San Carlos Buoy to Pier.
4.—Waves become crowded near the Pier.
5.—The east wind has probably diminished the velocity of the waves.
6.

* On this day, the height of the waves, unbroken, was measured, by means of many observations. The mean level of smooth water on the tide gauge was noted, and the eye of the observer being 32 feet above the sea level, his visible horizon was 39,520 feet. The buoy on the Tinker Shoal was distant 6,180 feet, and as the waves reached this buoy and raised it, the summit of the wave was in a line with the observer's eye and his visible horizon. Since the distance of the visible horizon and height of the eye are given, and the distance of the Tinker Buoy also given, the height of the waves at the buoy may be found, because, 39,520 : 32 feet :: 39,520—6,180 : 27 feet, the height of the wave above the mean level, and as the sea was breaking in a depth of five fathoms, the depressions were equal to the elevations ∴ the height between the two extremities, or rather hollow, would be 54 feet.

7.—Cranes being washed down on the breakwater.
8.—Tide ebbing, barometer rising, and sea breaking in five fathoms.
9.—Small waves have run into large ones.
10.—High water.
11.—Swell subsiding.
12.—These waves raised by the south-west wind of yesterday.
13 and 14.—These waves indicate an approaching south-west wind as they subside.

These results were noted with the greatest care, and may be taken as pretty correct. Without going into a discussion of the very many results that may be obtained by analyzing the table, I may state two or three facts, viz:—

1st.—The velocity of waves is retarded as they advance into shoaler water. I have actually seen a wave overtaken and emerge into another, No. 1.

2nd.—The velocity of waves is not dependent on their height, No. 8 and No. 10.

3rd.—These experiments on a large scale appear to prove a *result* obtained by Mr. Scott Russell on a *small* scale, viz., that when the depth of the water equals the height of a wave, it breaks, and becomes a wave of translation. (See No. 8, *remarks.*)

4th.—Deep water facilitates the undulations of waves, (September 28th, No. 6 and 7), the tide rose eight feet, and the increase in velocity of the waves was one-and-a-half feet per second.

Leaving your readers to make comparisons or draw conclusions, I may briefly assert that the hydrostatic and hydrodynamic force that water exerts is far from being so well understood as it should be by those who assume the duties or appellation of "civil engineer." The man who contrived the huge iron tank, which burst the other day at Liverpool, when only two-thirds full, destroying much property, and drowning several persons, knew nothing of the *pressure* that his tank would have to sustain when filled with water. The hydrostatic pressure at any depth, is as the square of the depth = the sum of all the pressures above it.* In computing the force that a wave is capable of exerting upon a solid immersed in the sea, we have to take into consideration the rate at which the water moves or impinges against the solid, in addition to the hydrostatic pressure upon it. There are many gentlemen who add C.E. to their names, and who believe that the impulse of a volume of water in motion upon a solid structure opposing it, will be as the volume into the velocity, as is the case when one solid impinges upon another, as a mass of ice upon a stone. But a little reflection will convince us that the force which a volume of water moving exerts upon a solid obstacle, is not proportional to the velocity of water, but to the *square* of its velocity. The velocity with which a wave is thrown forward is equal to the velocity with which the *undulation* was previously moving, and although a very high wave is always dangerous, it is not always the very highest waves that are the most destructive.

If reference be made to the table of observations, it will be seen that No. 7 had waves moving at the rate of forty-six feet per second; these waves were far apart, and of middling height. They were, however washing the huge blocks of marble about on the breakwater, and knocking down the cranes upon it, whilst much higher and more crowded waves moving at the rate of 41·8 feet per second, were less destructive to the works, (*see* No. 8.)

The effect being, (ceteris paribus), as the square of the velocity, we may estimate what the height of the waves, moving at the rate of 46 feet, shou'd be, to equal the impulse of the waves 27 feet high, and travelling at the rate of 41·8 feet per second.

Put x = the required height.

Then $41{\cdot}8^2 \times 27 = 46^2\,x$. Now by this equation the value of $x = 22$ feet. Hence it would appear the height of the waves on the 28th of September must have been greater than twenty-two feet to produce the results upon the breakwater, although their height was certainly less than the height of those measured on the following day.

William Walker.

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* There is a slight ambiguity here. It is the total amount of pressure on the vertical sides of the tank which varies as the square of the depth—the pressure on any one point varies as the depth simply.

We are told further on, in the text, that the resistance of the wave does not follow the laws of impact of solids, but varies as the square of the velocity. Views so vague as these ought not to be expressed by a writer who takes upon him to condemn the philosophy of others. It is indeed usually assumed that the resistance of fluids varies as the extent of surface and the square of the velocity conjointly. But this law is only approximate, and "a little reflection will" not "convince us" of its truth, as that can only be ascertained by direct experiment, and cannot be proved by independent reasoning.—[Ed. C. E. & A. Journal.]

ON THE TEMPERATURE OF THE EARTH AND SEA.

A Lecture on this subject was delivered at the Royal Institution, by Mr. S. A. Taylor. He observed, that the atmosphere is an ærial film surrounding the earth, but, although of almost inappreciable thinness when compared with the earth's diameter, it forms a non-conducting investment resisting the radiation of terrestrial heat into space. The mean density of the earth, according to Baily, is 5·66, or about twice 2·8, the density of rocks and strata constituting its surface. We infer from hence that the mass of the earth, must be formed of materials lighter than the common metals, as iron, tin, lead, &c. Its specific gravity falls between that of titanium and tellurium. From careful inquiry it appears that the temperature of the *surface* of this planet depends entirely on heat acquired from the sun. Part of the heat thus received is conducted to a certain depth below the earth's surface; and part radiates into space. The greatest natural cold on the surface was observed by Erman at Yakutsk, the capital of Eastern Siberia, where the thermometer stood at 72 deg. below the zero of Fahrenheit. The temperature of space beyond the limits of the atmosphere must therefore be much colder—too cold to admit of the maintenance of life under its present conditions. The heat of the sun penetrates the earth to but a very small depth. Diurnal variations of temperature are not perceived below two or three feet, while the annual variations do not affect the earth's crust below 1-400,000th of the diameter of this planet. On the alternate heating and cooling of this film of depth depend the vicissitudes of climates, seasons, and cycles of years.

Mr. Taylor then stated, that, at a certain depth below the earth's surface, there is a stratum at which the thermometer is almost stationary. This stratum is consequently termed *the stratum of invariable temperature*. The depth of this stratum depends—1st, on the directness with which the sun's rays fall; and, 2nd, on the conducting power of the superficial strata. It must, therefore, be different at different localities. At Paris the depth of this stratum has been accurately ascertained to be 90 feet below the surface, at which depth the temperature has, for 50 years, remained constant at 53 deg. Fah. In other different parts of the world, this stratum varies in depth from reasons already assigned. In the tropics it is three or four feet, in the temperate regions from 55 to 60 feet below the surface, while in the regions of extreme cold, solar influence does not extend beyond three or four feet, the ground below this depth being found always frozen, to the extent of 400 feet. Generally, however, the temperature of this invariable stratum differs but little from the mean temperature of the place. Mr. Taylor then directed attention to the important and universal truth, that, when carried below this stratum of invariable temperature, the thermometer rises. The rise is not, however, the same at all depths in all places. As there are *iso-thermal* lines *on* the earth's surface, so there are *iso-geothermal* lines *beneath* it. Many localities, as five of the principal mines in Cornwall, the well of Grenelle at Paris, the Monkwearmouth mine of Sunderland, Joseph's Well at Cairo, &c., were noticed as indicating the great curvature of the iso-geothermal line.

The theory of the existence of internal heat was then established from—

1. This progressive rise of the thermometer in descending into mines and other excavations.
2. The high temperature of the water of artesian wells.
3. The high temperature of natural thermal baths or springs.
4. The phenomena of volcanic eruptions and earthquakes.

From accurate examination of these sources of inquiry, there has been found that the thermometer rises in mines one degree for about every 50 feet of depth; a result confirmed by the fact that the temperature of water in artesian wells increases in about the same proportion to their depth. The heat of thermal springs has been found equal to that of boiling water, and the perfectly fused condition of substances ejected from volcanoes indicates a temperature of 1000 deg. The opinions of various philosophers respecting the cause of the central heat of the world were reviewed. Buffon held that the earth was a vitrified ball in the act of cooling; Leslie and Halley that it was a hollow sphere, made up of stories like a house; others, that the interior of the earth is in a perfectly molten state, the heat at twenty miles below the surface being sufficient to melt granite. Having pointed out the objections to these various hypotheses, Mr. Taylor affirmed, as an apparently certain fact, that this internal heat does not affect the temperature of the earth's surface. He particularly dwelt on a calculation made by Arago, that if in the period of 2000 years the earth had cooled only 1-300th of a degree, the fact would have been indicated by a difference in the length of the day, in consequence of that contraction of its diameter which any diminished temperature of that planet would have occasioned. Mr. Taylor quoted also records which proved that the climate of Tuscany has undergone no change during the last 200 years. With respect to the temperature of the sea, many difficulties are offered to accurate observation. The uncertainty as to the depth to which thermometers can be sunk, the influence of cold and warm currents, the laws regarding the circulation of heat in liquids, and the effects of heat on the density of water, present serious obstacles to accurate results. The most careful observations and calculations give an oceanic temperature of from 34 deg. to 44 deg. It is probable that the submarine strata are sufficiently thick to prevent the free conduction of central heat, while the effects of heat on the density of water, together with its rapid diffusion throughout the mass of the ocean, would render a high temperature imperceptible at any one point. On the other hand, the abundance of insular volcanoes sufficiently testifies the existence of igneous matter beneath.

From these considerations, Mr. Taylor concluded—

1. That, at a certain depth below the surface of the earth, there is a source of heat which increases as we descend.

2. That this heat cannot be derived either from the sun or from chemical changes.

3. That this heat neither perceptibly affects climates or seasons, nor influences the temperature of the surface of the earth, nor of the depths of the ocean, nor of the atmosphere.

4. That the vicissitudes of climates and seasons are entirely referrible to solar influence.

5. That this influence, even at its maximum, does not penetrate below 1-400,000th of the earth's diameter.

6. That, although we have positive evidence that subterranean heat exists, we can neither measure its intensity, nor determine the exact ratio of its increase towards the centre of the earth.

7. That there is no evidence to show that the earth is gradually cooling from a high temperature.

EXPLOSION IN A SEWER AT IXELLES.

A report has recently been published in a Brussels Journal on the causes of an explosion which occurred on the 2nd of January last, at Ixelles. The following account is taken from this report, which however we have not translated very faithfully, as in several places we have made omissions for the sake of brevity. The report is signed by M.M. Nollet, Dieudonné and Spaak; their principal object seems to be to remove all apprehension as to the possibility of explosive gases being generated in sewers.

It is stated that the street gas pipe under the Etterbeek road was broken, and that in consequence there was an abundant escape of gas which penetrated the sewer in which the explosion took place. Another main gas pipe under the Ixelles road was also broken; but this second accident might have resulted from the explosion, which caused a great deal of damage in the neighbourhood. The sewer in which the explosion took place had been in use only twelve days. The commissioners on entering the sewer in which there was room to stand upright, found in it water slightly blackened; but the flame of a candle burned in it as brightly as in the external air, respiration was not impeded, and there was but very little odour.

The water from the Ixelles road after passing through trapped gratings falls into a brick cistern, from which the overflow, after leaving the heavier deposits in the cistern, passes into a conduit from which the liquid deprived of the insoluble matter* passes into the sewer.

Much rain had previously fallen. The water was consequently constantly renewed; the temperature of it was also below zero (centigrade), and there was little vegetable matter present.

Two questions presented themselves. Was it possible, as had been suggested, that carbonated hydrogen could have been generated in the sewer itself, and there formed an explosive mixture? Again, in what manner could this mixture have been produced?

The reply to the first question is, that carbonated hydrogen could not have been formed either in the sewer or the branch pipes; that neither the nature of the substances, nor their stagnation, nor the degree of temperature, nor the length of time, four conditions requisite for the supposed decomposition, permitted this hypothesis.

If it be true that in the Pontine Marshes and other marshy places where there is a large quantity of mud, composed principally of the detritus of vegetable matter, and constantly covered by water heated by the sun, bubbles of carbonated hydrogen escape, especially when the mud is stirred, it is when the four conditions determined above concur to produce the phenomenon.

But it may be said that sewers contain fæces and other animal substances. The examination of the nature of the gas emanating from these substances has been undertaken by a commission appointed in Paris to superintend the purifying of ancient sewers. The average of 21 experiments gives the following result:—

Oxygen	18·10
Azote	78·70
Carbonic acid gas	2·80
Sulphuretted hydrogen	·90
	100·00

In no instance was the gas inflamed during the visits: on the contrary it was remarked that the flame of a candle burned feebly and sometimes was extinguished. This was a necessary consequence of the composition of a gaseous mixture in the sewer of Rue du Chemin Vert at Paris, of which the following is the analysis.

Oxygen	13·79
Azote	81·21
Carbonic acid gas	2·01
Sulphuretted hydrogen	2·99
	100·00

This gas was asphyxiant; it instantly extinguished the flame of a taper.

In one instance only M Serpette, Inspector-General of Sewers, at Paris, found a gas which inflamed on the introduction of a lamp; the flame of the gas went out and again caught fire, but this phenomenon which never occurred, but in this one instance, took place in a sewer of the Rue du Ponceau, where the mud was very deep and had long been undisturbed, and the gas burned without explosion. All the facts are detailed in the work published by Parent du Chatelet on the sewers of Paris, and in his treatise on public health published in 1836.

One more instance is known of fire occurring in a sewer at the approach of a flame, but this occurred from the passage into this sewer of a liquid refuse containing a large quantity of tar produced at some neighbouring gas works.

With respect to the explosion in the main sewer at Ixelles, it is ascertained that the main gas pipe was broken before the explosion near the drain of the Etterbeek road took place. Several days before the accident occurred a strong odour of street gas was perceived in the neighbourhood. This odour is easily distinguished from that of drains, and it was so strong that notice of the escape of gas had been given at the gas works. It is to the mixture of this gas with the air of the drain that the explosion must be attributed.

To prevent the recurrence of so serious an accident, it is proposed to make the gas tubes of increased thickness where they traverse cross streets, and to imbed them in brickwork. It is also proposed to replace the existing close covers of the drains by openings which will facilitate the renewal of the air. The inside of the drains also has been carefully coated with plaster, so that there is no cause to apprehend that a detonating mixture can be again formed under circumstances resembling those which led to this disastrous explosion.

* On the other hand it is stated in a memoir, by Dupuytren, on the mephitic air of cesspools (Journal de Medecine, Vol. XI.) that on analysing the air in one of these places there were—

Azote	94
Oxygen	2
Carbonate of ammonia	4
	100

In another case there were—

Azote	89
Oxygen	6
Carbonic acid gas	5
	100

Height of Vesuvius.—According to the latest observations of the scientific men charged with the geodetical works of the kingdom of Naples, the height of Vesuvius, at its most elevated point—a point which has undergone no change for many years—the *punta del Palo*, is 1203¼ mètres (3948 feet) above the mean level of the sea.

STYLES AND METHODS OF PAINTING SUITED TO THE DECORATION OF PUBLIC BUILDINGS.

By C. L. Eastlake, R.A.

Secretary to the Commissioners on the Fine Arts.

External Conditions of Works of Art.

The materials and dimensions of works of Art, and the situations and lights for which they may be intended, are termed *external conditions;* as distinguished from the character of subjects, the aims of individual artists, the tendencies of general taste, and similar influences. The former class only, as affording definite grounds for investigating and as suggesting practical inferences, can here be considered.[1]

Whatever be the external conditions, it is essential that the visible impression of the work should, under the circumstances, be as complete as possible. To insure this, not only the executive means, but the qualities to be represented still require to be adapted or selected accordingly as conditions vary. Such methods and resources constitute in each case a specific and appropriate *style;* the criterion of which is, that the amount of excellence resulting from it is unattainable in the same degree by any other means.

The question respecting the relation of painting to external conditions is not unimportant in considering the tendencies and claims of different schools. In general, the great masters seem to have inquired what the outward resources at their command could best effect. Such a habit, instead of confining, was rather calculated to enlarge their invention and to vary its forms. The result of their labours is the sufficient ground of the world's admiration; but their docility cannot be duly appreciated without a reference to the local circumstances under which they worked.

An inquiry into the principles which may regulate such varieties of style appears to be especially requisite when painting is employed in the permanent decoration of public buildings, and may now be resumed with a more direct object, as particular localities in the new Houses of Parliament approach their completion. In such further investigation it may sometimes be necessary to advert to the statements and illustrations that have been before submitted.

The conditions now proposed to be considered are—

Dimensions, Situation, Light, and the Means of Representation.

Large dimensions (in respect to the size of the entire painting), requiring a corresponding point of view; the height at which the work may be placed, requiring a distant point of view independently of dimensions; imperfect light; and a method of painting possessing limited technical resources, are all to be considered as *causes of indistinctness,*[2] requiring to be counteracted by such means as the method of art adopted can command; by such means as may appear preferable on general grounds, and which, supposing its practical difficulties overcome, may render that method the fittest.

The relation between the longest dimension of a picture, and the distance from which the work requires to be viewed, may here require to be again remembered. Once and a half the extent of the longest dimension (whether in width or height is immaterial) is the minimum of distance to which the spectator can retire in order to see the entire surface. A circle cannot be embraced by the eye till the spectator retire to a distance equal to once and a half its diameter.

The law relating to the next condition is a necessary consequence of this. In some cases, the situation of a picture, independently of its dimensions, may require that the work should be viewed at a considerable distance. A painting placed opposite the eye, and measuring 14 feet high (such being assumed to be its longest dimension), would require, according to the foregoing law, to be seen at a distance of 21 feet. But if the lower edge of that painting be 26 feet from the ground, the spectator must retire to the distance of at least 60 feet before the eye can embrace it; for a painting equal to the whole height (40 feet) would require that distance.

This is the state of the case with regard to the compartments to be painted in the House of Lords. They are 26 feet from the floor, and may be reckoned to be about 14 feet high.[3]

At the end opposite the throne, the compartments are in recesses, and will be less fully lighted. At this end, therefore, all the causes of indistinctness above enumerated are combined, and may suggest a counteracting treatment in the paintings accordingly.

If, on the one hand, these considerations may furnish an answer to those who look for finish and minuteness of detail in specimens of fresco-painting that have reference to such a situation; it will be acknowledged, on the other, that the general treatment which may be calculated to correct the consequences of such conditions is a problem requiring some experience to solve. Fortunately, a reference is possible to the example of great artists under similar circumstances.

Dimensions.

The instances are not frequent in which the size of the objects represented on a large surface is too small for the distance which the size of the entire painting requires. Raphael's first work in the Vatican, called 'The Dispute of the Sacrament,' would be such an instance if the room in which it is painted were large enough for the spectator to retire to the requisite distance. This is not possible; the whole of the painting cannot be embraced by the eye at once. The experiment can, however, easily be made with the engraving; the small size of the figures, as compared with that of the entire work, is then apparent. This imperfection, as is well known, was rectified by the artist in his subsequent works in the Vatican.

Situation.[4]

The next condition—situation, without reference to dimensions, presents greater difficulty. Michael Angelo, after having painted the second compartment in the ceiling of the Sistine Chapel—about 60 feet high—appears to have found (as is, in fact, the case) that the size of the figures was inadequate to the distance at which they were to be seen. Condivi relates that the artist was on the point of abandoning the work because of some supposed defect in the lime; but the real cause of his temporary dissatisfaction is apparent in the subsequent change in his style; the figures in the compartments last executed being more than thrice the size of those in the first paintings.[5] Thus, whatever may be the dimensions of the picture (and in ceilings the compartments are commonly smaller than the distance would require), the size of the figures must always have reference to the place of the spectator.[6]

In this instance, therefore, although the space was scanned by an experienced eye, the means employed to counteract the effect of the existing conditions were miscalculated. The example shows the necessity of simplicity, magnitude, and distinctness for works requiring to be seen at a distance, and is also valuable as affording encouragement to our artists, should they think that their first efforts are in any respects not altogether adapted to the place for which they were intended.

Light.

It will appear from the practice of another great painter, that imperfect light required, in like manner, magnitude and simplicity of parts; while, at the same time, large masses of deep shade were avoided. The frescoes of Correggio, in the tribune of the church of S. Giovanni in Parma, were remarkable for these qualities. An idea may be formed of their general style by the portion which remains (now in the library at Parma, representing the 'Coronation of the Virgin'). Pungileoni remarks[7] that the figures generally were considerably larger than life, not so much in this instance on account of their distance from the spectator as because they were seen by a subdued, reflected light. The result was probably satisfactory; for objects require to be magnified, even when seen near, to counteract the indistinctness arising from want of light.

Means of Representation.

A fourth case is that in which the indistinctness to be guarded against arises from the means of representation. Fresco, with its limited scale of colour, cannot produce such varied effects as oil-painting; but a much stronger instance of defective means and of the excellencies which the necessity of counteracting them may induce, is to be found in the Cartoons of Raphael. The ultimate works for which the Cartoons served were copies wrought in tapestry—a mode of representation which, in the early part of the sixteenth century, was far from exhibiting even the comparative force of colour, and light and shade which it afterwards attained.[8] With a view to such faint transcripts, however, the great artist worked; he knew that his drawings would be transferred to them, and that in the tapestries alone, possibly, his designs might live.[9] Distinctness was nevertheless attained, without any sacrifice of such of the proper attributes of painting as was compatible with the means employed; and without any violation of probability. When we consider the great qualities which were combined

1 It has not been thought necessary again to consider the question of the adaptation of style in painting to that of the architecture of the new Houses of Parliament. It may be sufficient to repeat that the Tudor style in England is coeval with the best examples of Italian art, and that if Raphael had accepted the invitation of Henry VIII. to visit this country, edifices erected during or before the reign of that monarch might have been adorned with the great artist's works. Second Report, p. 65. Compare First Report, p. 19.

2 It is necessary to separate the causes from the remedies of indistinctness. A distant point of view, whether the consequence of the size of the work or of its situation, is in itself a cause of indistinctness; the size of the objects represented, if calculated to counteract this, is among the remedies, but, it will appear, may sometimes be overlooked.

3 The height of the compartments to the point of the (Gothic) arch is 16 feet; but the picture, properly so called, may be considered to terminate two feet lower.

4 In pictures of processions or unconnected incidents, the treatment here referred to cannot be considered a defect.

5 The figures in the third compartment correspond in size with those in the first (either for the sake of uniformity or because the scaffolding immediately under the ceiling prevented the artist from making his observations earlier); the great change begins in the fourth. It is scarcely necessary to observe that large foreground figures are quite compatible with subjects requiring numerous actors. Michael Angelo's treatment of the subject of Haman is an example. The figures in the subject of Noah (the first ceiling compartment) might, even with the present composition, have been as large as those in the Creation of Eve. The circumstance of the ceiling subjects last executed requiring fewer figures is therefore not to be considered the only cause of the change in the artist's style. See Condivi, Vita di Michelagnolo Buonarotti, Firenze, 1746, p. 27. The first edition of this work was published in Rome, 1553, in Michael Angelo's lifetime.

6 The subjects in the small gold-coloured medallions in the ceiling of the Sistine chapel must have been, even at first, almost invisible from below. They are, however, to be regarded as mere decorations.

7 Memorie Istoriche di Antonio Allegri, Parma, 1817, vol. i., p. 134.

8 The admiration of Italian contemporaries is excusable, from the novelty of the manufacture at that period. The praises of Paris de Grassis, Vasari, and others may be compared with the juster remarks of Gunn, Cartonensia, London, 1832, p. 85; and Cattermole, The Book of the Cartoons, London, 1840, p. 21.

9 Such designs were treated as mere working drawings; they were cut into slips for the execution of the tapestries, and were then thrown aside till again wanted for the same purpose. It was in this mutilated state that the cartoons at Hampton Court were first brought from Flanders. See Quatremere de Quincy and Longhena, Istoria, &c., di Raffaello Sanzio, Milan, 1829, p. 586; and Trull, Raphael Vindicated, London, 1840, p. 8.

with these requisites—when we find that such apparently unpromising conditions had the effect of raising even Raphael above himself, we can hardly refuse to admit that a due employment of limited means of representation may, at least, invite attention to the most important attributes of art.

In cases like those that have been adduced it is probable that the qualities which might fit the works for the circumstances of place, light, or materials for which they had been calculated, would be looked upon as defects on near inspection. The critics on art who have had the best right to exercise an unrestricted judgment, have ever dwelt on the necessity of inquiring what qualities are to be chiefly looked for in the subjects of our observation.[10] It may be sometimes requisite even for persons of cultivated judgment to bear in mind that the excellencies on which the highest reputation of great artists is founded, are to be sought, not so much in the beauty of parts as in the grand or tasteful arrangement of the combined work, in the harmonious relation of entire masses, and the grace of entire forms. These qualities, which suppose the labour of the mind because they have reference to a whole, have ever constituted the worthiest criterions of merit, in the practice of the arts.

The influence of conditions, similar to those in question, on every department of painting, may be traced in the works of great artists; for, from whatever cause the sense of vision is imperfectly addressed, the selection both of qualities in nature and of the technical means fitted to represent them, will be influenced accordingly. But, before pursuing the inquiry, it may be desirable to state the elementary facts connected with visible distinctness, since these, though familiar in reference to nature, are more complex in relation to works of art when seen under particular circumstances.

Causes of Distinctness in Nature.

They have been defined as follows: an object in Nature can only be apparent, by differing in its visible attributes from what surrounds it. The chief causes of this distinctness are—difference of position; of mere magnitude; of light and shade; of form, and of colour.

Accordingly these attributes constitute the general resources of the artist; but it will be for him to inquire which of those means are more especially calculated, under any extraordinary conditions, to produce a result which shall satisfy the eye. The nature of the resources themselves will require to be first considered.

Position.

The differences of Position exist either superficially or in depth. In basso-rilievo, for instance, they are (either in the horizontal or perpendicular sense) superficial. In painting, on the other hand, although they are superficial as regards the actual plane, they are chiefly sought and expressed in (apparent) depth; one of the great aims of this art being to conceal the flat surface and to represent space. Various practical and other considerations, presently to be noticed, tend, however, to limit this attribute in works executed under the conditions before supposed.

Magnitude.

The differences of Magnitude are either real, [12] as at one and the same distance; or may be only apparent, as the result of perspective. The subdivisions of the remaining causes of distinctness above enumerated will be referred to hereafter.

It must be evident that gradations in magnitude will be more full and varied when they comprehend, if only in a limited degree, the perspective diminution of forms. The great Italian artists seem to have considered this essential to distinguish painting, however severe in style, from basso-rilievo, in which the varieties of magnitude are real.[13] But in the works before referred to by Michael Angelo and Raphael, this perspective diminution of figures is confined to narrow limits; partly because the technical means may have been wanting to mark the relative distances of objects when the work was seen under the conditions required; but chiefly because figures much reduced in size cannot be consistently rendered expressive as actors or spectators. In the second compartment of the ceiling in the Sistine Chapel before mentioned, the effects of the perspective are expressed without restraint; but the indistinctness which was the consequence was probably among the causes that induced Michael Angelo to reduce the space in depth in the other compartments (as regards the figures) almost to the conditions of sculpture. In Raphael's Transfiguration the figures on the Mount are supposed to be distant with reference to those below; but, had they been so represented, they would have been devoid of meaning and importance: they are, therefore, by a judicious liberty, brought within that range of vision where expression, actoin, and form are cognizable.

On great exception is, however, not to be overlooked. Correggio, who was devoted to picturesque gradation under all circumstances, and sometimes at any sacrifice, adopted a different course. The perspective diminution in the cupolas at Parma (to say nothing of the objects being represented as if above the eye) is extreme; so that even the principal figures are altogether subservient to the expression of space. This was the chief object; but the grandeur of form and character which the nearer figures exhibit has been justly considered to place these works far above subsequent efforts of the kind, which, in the hands of the "machinists," soon degenerated to mere decoration.

If the criticisms which the frescoes in the Duomo at Parma called forth on their completion had any foundation, it may be inferred that the great distance at which the figures were seen rendered it impossible, in some cases, to discern the nicer gradations of light and shade which are essential to make perspective appearances intelligible. Such considerations must, at all events, operate to restrict foreshortening under similar circumstances. But here, again, it is to be remembered that painting is still distinguished from basso-rilievo. Examples of foreshortening are accordingly to be met with in works intended to be seen at a considerable distance, and in which the technical resources were very limited; for instance, in the Cartoons of Raphael. The amount of foreshortening which is introduced in them may be considered to be the just medium. Its effect in rounding and connecting the groups, and in giving a due impression of depth, is in accordance with the truth of those works in other respects, and (even in the tapestries, while in their unfaded state,) may have been quite compatible with distinctness.

The transition from this picturesque treatment, and still more from the unlimited depth of Correggio's compositions, to the flatness of a style resembling that of the early mosaics, is violent indeed.[14] In cases where a gold ground is introduced behind the figures, painting really approximates to basso-rilievo, and to the conditions of the Greek monochroms, without even the advantage of the figures and the ground being of the same quality. Under such circumstances, neither perspective nor foreshortening can be introduced to any extent. The varieties of "Position" are almost confined to one and the same plane, and consequently the relations of Magnitude are real. The splendour of the gilt field, though subdued by being roughened (for this is absolutely necessary), betrays the comparative dulness of the painted surface, and the final outlines on the ground (even making allowance for the gradation of real light on a large resplendent surface) are in danger of being too uniformly distinct, unless a darkening colour be partially added to the gold.

The union of absolute reality with imitation is rarely, if ever, satisfactory, as it is essential that the most important qualities should exhibit the nearest approach to nature. As an accompaniment to painting, there is, therefore, no defence for the gilt ground, when it appears as such. For the rest, it cannot be admitted, on the one hand, that art need be reduced to mediæval penury in order to agree with this hard condition, if adopted; nor on the other, that even the extreme restrictions in representation which it actually involves, considered in themselves, necessarily suppose incompleteness. An analogous style springs from those restrictions which, in adhering to its own resources, may still have its characteristic perfection. Wherever there is gradation, wherever a greater quality becomes conspicuous by comparison with the lesser (even if abstract lines alone be the means of representation), we recognize an important principle of art.

Light and Shade.

The influence of the general conditions before mentioned may next be considered with reference to Light and Shade. The varieties of this source of distinctness, though infinite, are, like those of Magnitude, merely differences of degree. The circumstances best calculated to display it will be again considered in examining its relation to colour.

The example of Correggio, which was adduced with reference to perspective and foreshortening, may also appear to recommend the employment of chiaro-scuro without restriction, under any circumstances; but this, his favourite attribute, was confined, in the instances of the cupolas at Parma as compared with his oil pictures, to a light scale, especially in the upper portions of those cupolas. It is evident that a dark effect would have ill suited both the places and the subjects.

The instances are rare, and not always successful, in which extensive surfaces, whether on canvas or on walls, have been covered with masses of low half light and deep shade. Such masses, as is well known, are especially ill adapted for fresco, on account of its tendency to reflect light only from its surface.[15] Among larger works of the kind, one of the best specimens is perhaps Raphael's fresco of the Deliverance of Peter from Prison. But, although successful in this instance (as far as the material permitted), the great artist did not resort to the same style on other occasions; on the contrary, in a subsequent work, the Incendio del Borgo, in which the subject might have justified a free use of chiaro-scuro, he did not employ it to any great extent. The reasons for employing it in the first instance appear to have been accidental.[16]

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[10] See Reynolds, Fourth Discourse, and the Idler, No. 79.

[11] Position is added by Professor Whewell (Bridgewater Treatise, p. 130). Abstract magnitude may be allowed to form a separate class, as spheres (for example) of different sizes may be said to differ rather in magnitude than in form.

[12] The term 'real magnitude,' in painting, is restricted to such superficial dimensions as have a permanent relation to each other. Under this category may be classed proportion or symmetry.

[13] The style of basso-rilievo, as generally practised by the Italians, was not strictly in conformity with this definition, as they injudiciously endeavoured to represent in it the effects of perspective.

[14] The general predilection for all the modes of decoration which belong to the "renaissance" may be an excuse for here briefly reconsidering the claims of the gilt ground in itself, and with reference to peculiar conditions in representation.

[15] It may at first appear that all pictures reflect light from their mere surface, but this is not, strictly speaking, the case. One great charm of oil-painting is its power to reflect light from an internal surface, through superposed substances more or less diaphanous.

[16] Among the painters whose frescoes, previously executed on the walls of the same apartment, were destroyed to make room for the superior works of Raphael, Vasari mentions Pietro della Francesca. This artist was remarkable for his study of chiaro-scuro, and in that department of art had probably considerable influence on his contemporaries and successors. The subject of his work here referred to is unknown, but supposing it to have exhibited a striking effect of light (like his Vision of Constantine), it is quite conceivable that Raphael should aim at similar qualities in substituting for it a work of his own.—See Vasari, Vita di Piero della Francesca, and Vita di Raffaello, and Passavant,

Other examples, with all their excellence and even with the advantages of the richer method of oil painting, are more or less unsatisfactory, from causes independent of the materials. The night scene of the Martyrdom of S. Lorenzo, by Titian, is heavy in its effect.[17] Of Tintoret's darker works it would be unfair to speak, as the shadows have too often become black, either by time or by some mischievous technical process.[18] The celebrated Nightwatch, as it is called, by Rembrandt, is generally acknowledged to be overloaded with shade;[19] and the Santa Petronilla of Guercino is a monument of great, but in that instance, misdirected powers. These are the most remarkable examples of dark pictures on a colossal scale. The Last Judgment, by Michael Angelo, now obscured by time and the smoke of candles, must always have had a solemn effect from the depth of the flesh colour (a treatment which may be traced to the influence of Sebastiao del Piombo), but there are no masses of deep shade. As the work is in fresco, mere blackness would have been the result had such been introduced.

The unfitness of masses of extreme shade in paintings of considerable dimensions (without reference to the material) is explained by the fact that the distance at which the work requires to be viewed tends to obliterate the fainter lights and reflections in such masses, thus changing depth to flat obscurity.[20] In subjects which require gloom, it is still essential that the indistinctness should be felt to be intentional, and not to be the result of such distance. The size of the work should admit of the spectator being so placed as to see all that the artist intended to be seen. The 'Notte' of Correggio can be thus perfectly seen at the distance which its size requires; but, in looking at the 'Night-watch' of Rembrandt, under like conditions, the spectator is presently compelled to draw nearer. The conclusion is, that the amount of darkness in the latter is too great for its size, and on the other hand, that moderate dimensions may render such a treatment, if suitable on other accounts, not only unobjectionable, but desirable. The finer gradations of low tones can be appreciated only on near inspection. Subjects, the intended place of a work, or other circumstances, independently of dimensions,[21] may interfere with this consideration, but it is not the less true that the scarcity of light which would be inappropriate in a collossal picture is quite compatible with the physical conditions here referred to, in regard to works of smaller size.

The Venetian painters, as compared with those of the schools of Lombardy and the Netherlands, appear with few exceptions, to have systematically avoided a preponderance of deep shade.[22] This must be understood as meaning no more than that their treatment of light and shade was calculated for works of large dimensions. From the first, the great Venetian colourists were accustomed to execute frescoes in the open air, and sometimes in situations where the distance at which the paintings could be viewed was far greater than their size required.[23] The elements of distinctness and breadth were thus familiar to them, and, it must be confessed, were sometimes transferred to works which, admitting of near inspection, might have suggested a different treatment.

"Venetian shade," which, notwithstanding the occasional darings of Tintoret in more capricious directions, is characteristic of the school, and which the praise of Agostino Carracci has rendered proverbial, is the worthy auxiliary of composition on an extensive scale, and is fitted, by combining distinctness with breadth, to correct the uncertainty which arises from distance or want of light; it is calculated to give place and meaning to form, to display the remembered attributes of colour, and, while it renders force of local hues indispensable, to combine solidity with clearness. The view which the Venetian artists took of nature was consistent with the ordinary destination of their works.

They appear, in most cases, to have assumed that the objects to be represented were seen by the diffused light of the atmosphere, as opposed to the case where the light is derived from a particular source. The practical result of this is that intense shadow is smaller in quantity, and that the picture is chiefly composed of gradations of half and reflected light; brightness thus marking projection[24] and obscurity, depth. It has often been said that in Venetian pictures (more constantly than in those of other schools) the foreground objects are, relatively to their hues, the lightest; the retiring ones being lower in tone. The diminution of the force of shade in remoter masses, the introduction of accidental cast shadows, of dark hues near, and bright objects, buildings, or sky in the background and distance, may conceal without altering the artifice. This system of effect in Venetian pictures corresponds with that of general nature, and, like that, is too familiar to be remarked;[25] but its apparent simplicity conceals a scale of gradation the fulness of which may be more difficult to compass than the pronounced effects of confined light. Hence the unaffected character of "Venetian shade; and hence, at the same time, its powers in marking the essentials of form, while it leaves the general idea of colour unimpaired.[26]

If the artists of the northern schools may be accused of sometimes employing the effects of a confined light for scenes supposed to take place under the broad atmosphere, the Italian painters (for the practice was not confined to the Venetians) must be acknowledged to have as often adopted the opposite course; viz., that of representing scenes in interiors as if seen under a diffused light. They appear to have thought that objects so illumined are more intelligible in pictures requiring to be seen at a distance (as was the case with altar-pieces), and that such effects are in themselves more large and beautiful.

The effects themselves, though derived from the observation of nature in the open air, were produced by various artifices in Italian painting-rooms. The most common (still in use) was that of employing oiled paper instead of, or before, the glass of the window. A Madonna of Raphael's takes its name (dell' Impannata) from the oiled paper window, probably that of the painter's studio, in the background. Leonardo da Vinci, who is careful to distinguish between *ombra*, "the diminution of light," and *tenebre*, "the privation of light,"[27] frequently recommends attention to the effects above described, and speaks of the modes (probably then common) of producing them. He remarks that objects seen in a diffused light are more beautiful than when lighted from a confined source, and that when represented in pictures they are more intelligible at a distance.[28] He recommends the mitigated light of evening, or of cloudy weather, in preference to the direct light of the sun, in order that shadows may have due gradation.[29] He observes, that not only the equal force but the hardness of the boundaries of such shadows, if imitated in pictures, tends to render objects confused when seen at a distance.[30] The latter appearances (hard-edged shadows), he adds, "are especially condemned by painters." His contrivance for securing the larger effects which he recommends, is to stretch a linen awning across an open court. In one instance he suggests that the walls should be blackened; in another, that they should be painted flesh colour, and be altogether open to the sky. Elsewhere he mentions the "Impannata" (for ordinary lights);[31] and again proposes an expedient, similar in its results, for softening the edges and varying the strength of shadows by lamp light.

Neither Leonardo nor the Venetians were ever deficient in force; but the latter in making the fullest use of the principle thus dwelt on by the Florentine compensated for their comparatively small amount of '*tenebre*,' as nature compensates for it, viz., by intense local colours. This resource never led them to neglect the study of chiaro-scuro on their own large, and, it may be added, difficult principles, but only served to conceal its artifice. So intent were they on securing relief, as well as breadth of general effect by means of light and shade, that they frequently defined the perspective balance of light and shade. The expression is, however, usual and allowable, and the Venetians themselves were not more accurate; their technical term for 'lighting up' with the brush, was 'colmizare,' from colmo, summit, most prominent point. See Boschini, la Carta del Navegar Pitoresco, Ven. 1660, p. 288.—Light in hollows, or rather slight concavities (called by the French artists 'sillons lumineux'), is hardly an exception. In some cases, for example in plaster casts, the appearance is assisted by a difference of tint.

Rafael von Urbino, Leipzig, 1839, vol. i., pp. 192, 434-5. Of Raphael's fresco Wilkie observes, "the St. Peter in Prison, finely as it is arranged, is black and colourless." See Thoughts on the Relative Value of Fresco and Oil-painting, by B. R. Haydon, London, 1842, p. 31.

17 Compare Burnet, Practical Hints on Light and Shade in Painting, London, 1838, p. 4

18 This is the case even with some of the fine works in the Scuola di S. Rocco, in Venice.

19 See Reynolds, Journey to Flanders and Holland; and Kugler, Handbuch der Geschichte der Malerei, vol. ii., p. 178.

20 It has been before observed that although an object may be increased in magnitude to any extent, in proportion to its distance, and in order to accommodate the spectator, yet its force of light and shade cannot be increased beyond a certain point, and that point is supposed to be already attained in pictures requiring to be seen near. Not only is force not to be increased in proportion as distance increases, it is unavoidably diminished by it, in consequence of interposed air.

21 In modern exhibitions where no space is lost, and where, consequently, the eye is influenced by the effect of the mass, an entire wall approaches the conditions of a large picture. Hence the amount of light in the component parts of this decoration is required to be great. A subdued window light may also have its influence.

22 The relative amount of light, shade, and half-light, in the works of the colourists, as given by Reynolds, is well known, and it will be remembered that he made his observations chiefly from large pictures. See notes to Du Fresnoy.

23 The circumstance of Titian and Giorgione painting on the façade of the Fondaco de' Tedeschi is well known. (The remains of some of the figures there painted by them, now quite obliterated, were etched by Zanetti in the last century: two were engraved by Giacomo Piccino at an earlier period.) Examples of a similar kind by Pordenone and other artists still exist in Venice and in various towns of Friuli.

24 The "central light of a globe" (Fuseli, Second Lecture) would not be the most favourable, with reference to the spectator, for displaying the object, or for ensuring a

25 Thus in some of the vast compositions of Paul Veronese, although every figure keeps its place, the artifice of the gradations of light escapes observation, as it does in nature. The Venetians seem to have considered that the office of light is rather to exhibit the qualities of material objects than to display itself. Effects of light are generally confined in their works to the distance, where, as regards figures, form and colour are no longer important.

26 Zanetti (Della Pittura Veneziana. Ven. 1771, p. 99) justly observes, that in the heads of Titian the broader shades do not approach the force of the shadows under the features. Compare Barry, Works, vol. ii., pp. 45, 49, 51.

27 Trattato della Pittura. Roma, 1817, p. 274.

28 Ib., p. 357. "Distinctness of local colour and precision of outline, are the peculiar character of objects placed out of the effect of strong (sun) light." Burnet, Practical Hints on Colour in Painting, London, 1843, p. 18.

29 Ib., p. 336. When Reynolds, speaking of Vandyck's St. Sebastian, now at Munich, observes, that it is painted in his first manner (when he imitated Rubens and Titian), which "supposes the sun in the room," he can only mean the reflected or diffused rays, not the direct light, of the sun. The picture which he describes, sufficiently proves that the latter effect is not imitated. In some of Rubens's works, however, the effect approaches that of the direct sun-light.

30 Ib., p. 71. He elsewhere observes that objects represented with masses of intense shade, instead of appearing distinct at a distance, appear 'tinted.' Dark shades under such circumstances, (having no longer the quality of depth,) assume the effect of neutral colours. Ib. 248.—The equal force of shade in many of Guercino's pictures might exemplify the justness of Leonardo's remarks on that point, but the works of Paul Veronese often exhibit a modified and agreeable use of cast shadows. In preserving their comparative sharpness he reduces their force, so as to give the impression of a mitigated sunlight.

31 Ib, p. 70. The Impannata may mean cloth as well as oiled paper. Most of these contrivances, although not without interest as connected with the Italian practice of art, are obviously fit only for a bright climate; but the observation of nature and the technical expedients which were then habitual to the artists had also relation to the due effect of works in vast localities. It was the more essential to preserve the general appearances of nature in colour and light and shade, because the forms in votive altar-pieces were often individual.

depth of their compositions and the place of each figure by means of chiaro-scuro alone. Tintoret was in the habit of placing large paintings thus studied, but before any colour was added, in the situation which they were ultimately to occupy, in order to judge of their effect and keeping.[32] The habits of the Venetian and other colourists in thus occasionally preparing their pictures may be adverted to hereafter in an inquiry into the early methods of oil painting.

Form.

The treatment of form[33] which is applicable to pictures intended to be seen at some distance, has been already partly considered in reference to certain works by the great Italian masters. It is further to be observed that the means employed to insure distinctness in this department of painting may, without due caution, tend to confound its style with that of sculpture. It is obvious that forms are most intelligible when they are freest from peculiarities; therefore when in any extreme case it may be necessary to counteract indistinctness, it would appear that a generalized treatment is indispensable. But in sculpture this intelligible appearance can only be produced by means of form; whereas in painting, colour (which in like manner admits of a generalized treatment) can powerfully contribute to such a result. The representation of figures of unusually colossal dimensions need not be supposed.[34]

The grandest examples of painted figures on a colossal scale—the Prophets and Sibyls, by Michael Angelo, in the ceiling of the Sistine Chapel—do not exceed 15 feet. In such representations, as those celebrated works prove, painting can still maintain its complete independence as compared with the sister art. The figures in question though, strictly speaking, abstract conceptions, have the force of character of real beings. It is also to be observed that in the subjects by Raphael in the Vatican, the treatment of form does not approach the conditions of sculpture; as a proof of this it is to be remarked that the portraits introduced in those compositions do not appear incongruous. Thus, although it may be admitted that the most intelligible forms are those which are freest from accident, and that such forms must be best calculated for works intended to be viewed at some distance, yet it appears that, even in the most limited styles of painting, the degree of generalization which is necessary, with a view merely to distinctness, need not be confounded with the more abstract beauty of sculpture. If, again, the subject should require an approximation to the latter, the full display of the proper attributes of painting, which may be compatible with the existing external conditions, is indispensable. Thus colour enables painting to vary its forms and characters consistently with the intelligible effect at present assumed to be requisite, and is, therefore, the department of this art in which an abstract treatment can be best adopted consistently with its independence of sculpture. In general, the region of the 'ideal' (the largest view of nature) is more safely approached by means of attributes which are exclusively characteristic of the art; the poetic impressions of each mode of representation are then of a distinct order.

But to whatever extent characteristic details in living forms would be admissible in the higher styles of painting, the causes referred to would unquestionably operate to limit the introduction of inanimate objects and accessories, and would influence their treatment.

It is unnecessary to repeat what has been before observed on this subject; a consideration in connection with it is however not to be overlooked. Next to the great requisite that each mode of representation should rest chiefly on its own resources, the works of great artists teach the principle that the noblest object of imitation should always be the nearest to nature. In sculpture, and in painting when employed to represent human actors, this noblest object is life, with its attributes of action and thought. When the field for displaying this quality is even confined to a head, it is still required that no circumstance represented should surpass it in completeness of imitation. Rarely in the works of the best Greek sculptors or in those of the excellent modern painters does an inanimate object exceed in truth the representation of the living surface. The contrivances with a view to insure this insubordination are, necessarily, most daring in sculpture, in which certain qualities are in danger of being confounded with reality. It will generally be found that the employment of conventional methods (as opposed to the more direct truth of representation) increases in proportion as objects are easily imitable, and, consequently, in danger of interfering with the higher aim. Thus, to take an extreme case, rocks, which in marble are sometimes made identical with nature (thereby betraying the incompleteness of the art), are generally conventional in fine sculpture. Witness the basso-rilievo of Perseus and Andromeda, and various examples in statues where rocks form the support of the figure. In order to reduce what would easily amount to literal reality to the conditions of art, the substance in this instance is, so to speak, uncharacterized.[35]

In painting, the instances are rare in which such absolute identity with nature is possible.[36] The representation of a flat surface, of coloured patterns, and painted objects, are almost the only cases; and far less artifice is sufficient to reduce them to the conditions of imitation. But as regards the necessity of superior truth in the living surface, compared with all other objects, the principle is the same as in sculpture. The contrivances to insure this superiority, without violating nature or betraying the artifice, are among the distinguishing merits of fine pictures. Inanimate objects may often form a considerable part of a composition, and therefore cannot be neglected; the colourists, as has been often observed, have contrived to give interest to such subordinate materials, by dwelling on a portion only of the qualities of the substance, and selecting such qualities, with a view to give value to the flesh, as if they were merely forced into notice by the existing comparison. In the instances in sculpture where absolute identity with nature is to be guarded against, it appears that the substance requires to be in a great measure uncharacterized; in the cases now referred to, the objects are only partially characterized. The principle is, however, the same in both methods; art is permitted, or rather required, to be apparent, in proportion as nature is in danger of being too nearly approached.

Colour.

The general treatment of colour which is calculated to assist distinctness, cannot be better exemplified than by the practice of the Venetian school. It may be first necessary to recur to the elementary facts before noticed.

It was observed, that an object in nature can only be apparent by differing in its visible attributes from what surrounds it; its distinctness in a word, supposes the presence of some or more qualities which are wanting elsewhere. Thus, the imitation of the appearances of nature is especially conversant with differences; it is opposed to (absolute) equality, and is founded on Gradation and Contrast.

The first, a difference of degree, comprehends Magnitude and Light-and-shade. By means of their varieties,—perspective, depth, relief, and roundness, in other words, substance and space are represented.[37]

The second, a difference of kind, comprehends Form and Colour; by means of which physical and even moral characteristics are expressed. Position, as an incommunicable attribute, belongs to the same category.

The possible interchange of these two sources of variety (as regards their effects), is constantly exemplified in nature and in art. An abrupt difference of degree amounts, practically, to contrast; the full scale of differences of kind involves gradation. Contrast itself is imperfect without the auxiliary element, by means of which equality even of antagonism is prevented and one impression predominates.

The great office of colour is then to distinguish. Each object in nature has its own hue as well as its own form, and hence the origin of the painters' term 'local colour.' This characteristic difference becomes more strikingly conspicuous at a moderate distance, when objects are seen as wholes, and in their largest relations and oppositions; for in a nearer view, the eye is necessarily more confined to their component varieties.

On the contrary, light and shade, being common to all substances, and presenting differences of degree only, is less powerful at a distance as a means of distinguishing objects from each other; but in a nearer view, when its infinite gradations are appreciable, it is sufficient, without the addition of colour, to express the relative position even of contiguous objects, as well as of their component parts.

Accordingly, while chiaro-scuro in all its richness and delicacy is indispensable in pictures that are to be viewed near, colour is no less desirable in colossal works, or in such as can only be seen at a distance.

When employed under such circumstances by the Venetians, its larger appearance, above described, was selected in preference. The 'local hue,' displayed and influenced as it must be by what surrounds it, was especially dwelt on by them as a means of insuring distinctness. The union of due variety (a union which, in all cases, taste alone can define), with this integrity of local tint, has been considered to be one of the great excellencies of Titian, who, nevertheless, changed his style—accordingly as his works were to be seen in vast halls and churches, or in ordinary apartments—from the most daring force of local colour to the fuller har-

32 See the introductory "Breve Instruzione" in Boschini's Ricche Minere della Pittura Veneziana. Ven. 1674. Tintoret and Bassan, the darkest of the Venetian painters, are still examples, in their main aim, of the principles of the school. Their study of chiaro-scuro was, however, more derived from interior and even from nocturnal effects. Both were in the habit of using small models illumined artificially; less (in Bassan's case) for the sake of noting accidents of light than for the purpose of observing its gradation on objects more or less removed from its source. Boschini remarks that, with the Venetian painters, "every room answered the purpose of the open air;" meaning that they could give the effects of open light, either from contrivances like those above mentioned, or from observation and practice, wherever they might be placed while painting. See La Carta del Navegar, &c., pp. 72, 137, &c.; and Ridolfi, Delle Maraviglie dell' Arte. Ven. 1648, vol. 2, p. 65.

33 The 'differences of form' (almost another word for the visible world) can only be classed in their abstract elements, viz., as mere lines. These may vary in position, direction, and extent. Lines are said to be massed by extension; they may be contrasted in their direction, and are repeated by parallelism.

34 It is remarkable that the only ancient example on record of painting thus employed (by command of Nero) was a portrait. The figure, painted on cloth, measured more than 100 feet. The extreme modern instance, a consequence of the folly of the artist rather than of his employers, is the cupola of the cathedral at Florence, begun by Vasari, and finished by Zuccaro. One of the figures, if erect, would be about 50 feet. See Pliny, l. 35, c. 7, and Kugler, ib., p. 385.

35 The same liberty is observable in sculptured armour as treated by the ancients; sharpness is avoided, and the polish does not surpass, sometimes does not equal, that of the flesh. In like manner steps, or any portions of architecture, are irregular. On a similar principle, probably, the inscriptions on the finest antique medals are rudely formed; for it cannot be supposed that the artists who could treat the figures and heads so exquisitely could have been at a loss to execute mechanical details with precision.

36 Mere form is, or may be such an instance; but as, in painting, the imitation of substance and space is more or less incomplete, the literal truth of the mere outline, when present, is in no danger of confounding the work with nature.

37 The differences of degree which all visible qualities and their 'forms' may exhibit, are perhaps to be resolved into modifications or abstractions of Magnitude and Light, the representatives of mere gradation. Position comprehends augmenting or diminishing intervals. Colour, degrees of warmth and coldness, transparency and opacity, purity and commixture, intensity and lightness. The boundaries of substance, degrees of sharpness and softness in their relief. Mere lines, degrees of extent.

mony of broken tints observable in near objects. The abstract treatment is more exclusively the style of Giorgione;[88] by him it was first carried to its utmost limits, and was sometimes, perhaps, too indiscriminately employed, without reference to dimensions and distance.

The general style in question has been well defined (making some allowance for the stress on its leading attribute), by Mengs, whose observations on this subject are adopted by Fuseli. These writers observe, that "the breadth of local tint" referred to was attained by taking the predominant quality in a colour for the only quality; by painting a complexion, for instance, "which abounded in low tones, entirely in such tones, and by generalizing, in the opposite sense, another near it, of a lighter character; by painting a carnation, abounding in ruddier tints, entirely in such tints, and by depriving of all such tints its neighbour that had few." The aim being distinctness, qualities that were common to several objects were exaggerated in the one that had most, and comparatively suppressed in the others. The same principle, derived from the observation of nature in her largest aspects, was extended to every visible 'difference of kind.' The soft elasticity of flesh (ever a great object of the colourists) was, if possible, more than usually dwelt on in the neighbourhood of substances which, either from their general nature, or from the character which they were made to assume, were calculated to give it value; for not only inflexible and sharp substances, but sometimes drapery was made to serve this end, independently of colour, by abrupt folds, and crisply-painted lights. The shine on the surface of skin was omitted generally, but most so when polished surfaces were near it; while these were allowed to reflect light like mirrors. Gradation supported the comprehensive system; colours were varied not merely in their hues, but in their mass, degrees of brilliancy, and other qualities. Vivid colours were therefore few, and thus the end even of distinctness was harmony. Lastly, the same breadth which obliterated differences in detail, obliterated them also, to a certain extent, and according to the scheme of effect, in opposing masses; thus was insured, yet without the appearance of artifice, that plenitude of impression which the eye requires.

It must be apparent that not all the contrivances above adverted to would be applicable in works intended for a near view. The emphasis on local colours, for example, is in them no longer necessary to insure distinctness, and, moreover, might supersede peculiar beauties; yet the example of the colourists may show how much of this greatness of style may be sometimes infused with effect, even into narrow dimensions.

The system of the Venetians comprehended other methods, which may be considered, in a great measure, peculiar to the school, and which were equally calculated to counteract indistinctness. Among the means adopted by them for securing such a result, their treatment of certain colours, as affected by light and shade, merits attention. The artifice was, as usual, derived from the observation of nature in the open air. At that distance where the entire object acquires full force of local hue by the opposition of what surrounds it, the focus (if the expression may be allowed) of its colour will vary, according to the real depth or lightness of its tone. That focus will sometimes be in the illumined parts, sometimes in the 'diminished light,' which we call shadow, accordingly as the particular hue requires more or less light to display it. All forcible colours are most apparent in their brightest parts, even when the light is powerful. All delicate colours are impaired, and sometimes nearly effaced, in strong light, and are then most apparent in their shadowed portions, where they become deepened by means of reflection. But, let the same object be transferred from the open air to a confined or less vivid light, and the effect is reversed; the shadows become dark and, generally, neutral, and the colour is displayed in the light only. The larger system, though adopted by the Venetian painters from habit and predilection almost indiscriminately, was especially employed by them in works intended to be seen at some distance. Fulness and breadth were in such cases indispensable; and by a judicious use of the effects in question, they increased colour without sensibly diminishing light. The extreme and exaggerated instances of this treatment were generally in situations which admitted only of a distant view. The abuse of the style was indeed sufficiently guarded against by the principle, seldom forgotten in pictures of the school, that colours require in all cases te be more or less subdued and broken, for the sake of general harmony. This object was even partly attained by the practice referred to: the ordinary (and most commonly applicable) principle is, that colours should be neutralized in shade; but, in the excepted cases above described, where they are most displayed in reflection, they require to be, and are in nature, in a great measure suppressed and neutralized in their illumined parts. This is assisted by the colour of the light, which, although assumed to be nearly white, appears comparatively warm on cold light colours, and the contrary on warm ones. Harmony, therefore, was also promoted by this method.

The influence of certain conditions on the leading departments of painting has now been considered. In this examination, the effects of distance on objects in nature, and also on their painted representations, have been adverted to. The two are not to be confounded; but the question respecting their relation presents no difficulty in a practical view. It is quite certain that the most distinct and easily recognized appearances are best adapted for pictures requiring to be viewed at some distance. The machinery of art is selected accordingly. The point, or degree of remoteness in nature, where colour is most distinct (that is, most large and powerful), is not the point where form is so; for figures must, even at such a moderate distance, be considerably reduced by perspective. It is not the point where outline is so; for, in ordinary cases, outlines are soon blunted by distance. The artificial combination of the breadth of general appearances with due distinctness of form is not dictated merely by the necessities of particular conditions, nor is it confined to particular schools; it is a liberty which all have taken, and is one great source of what is called ideal beauty; for the "enchantment" which "distance lends" is thus combined with precision.

Such are among the expedients adopted by the great painters, in order to counteract indistinctness. The considerations which weighed with them may not only be applicable in similar cases, but may show the necessity of employing the resources of art generally for the same great object, viz., that of satisfying the eye in order to affect the mind. The selection and adaptation of particular resources, with reference to particular conditions; the view of nature, and the use of art which may be calculated for different circumstances; have all one and the same immediate end. But the test of a due application and economy of the means fitted for such various cases will be, that their conventions should be unmarked, and that art and its contrivances should be forgotten in their ultimate impression.

It remains to observe that if the qualities in various departments of art above considered are fit for works executed under the conditions of dimensions, situation, and light, before enumerated, then fresco-painting (supposing due practice in the method) is calculated to display those qualities. For example, its unfitness to represent large masses of shade is not objectionable because such a treatment is not desirable according to the above conditions. In colour, the stress on local hues and the integrity of masses (not incompatible with harmony and due gradation) which have been employed by great painters in works chiefly intended to be seen at a distance, are quite consistent with the resources of fresco; while in form, the distinctness and simplicity which appear to be desirable are especially adapted for its means.

It has been already observed that the Venetian painters were in a great measure indebted to the practice of fresco-painting for that comprehensive style of colouring which treats objects and their surrounding accompaniments in their largest relations. The early rivalry in fresco of Titian and Giorgione, on the exterior of an edifice near the Rialto, in Venice, has been already noticed. Their works, chiefly consisting of single figures, were there numerous. Besides that building, the following houses in Venice were painted on the outside by Giorgione. A façade near Santa Maria Zobenico, another near S. Vitale, two others in the same neighbourhood, the Casa Soranza, near S. Paolo, his own house, near S. Silvestro, and the Casa Grimani, near S. Ermacora. The houses painted fresco on the exterior, by Tintoret, Paul Veronese, Zelotti, Pordenone, Schiavone, Salviati, and others, would form, in each instance, a longer list.

The modern revivals of fresco on the continent appear to have chiefly had the Florentine style in view; it may remain for the English artist to engraft on this and on the maturer Roman taste the Venetian practice. It was formerly a question whether Venetian colour was compatible with the grandest style of painting, but that prejudice may be considered extinct. Unfortunately, the best of the Venetian frescoes were painted in the open air, and most of them live only in description. The frescos of Pordenone, in Piacenza, and two of Raphael's (the mass of Bolsena and the Heliodorus) in the Vatican, are probably among the best examples of colour in this method now existing. The last mentioned, according to every hypothesis, were painted under the influence of an artist of the Venetian school. Their date corresponds with the arrival in Rome of Sebastian del Piombo, whose powerful style of colouring may have been emulated by Raphael; and Morto da Feltre appears to have been employed on them. Both were of the school of Giorgione.

Opposite conditions to those first enumerated.

The resources which have been here dwelt on are to be considered as applicable, in many cases, to one class of conditions only. The different means and aims, which entirely opposite circumstances might require or suggest, have been already occasionally noticed, and may now be recapitulated; with a view to obviate the partial conclusions which a somewhat exclusive view might appear to involve.

The external conditions, relating to light, situation, dimensions and methods, at first proposed for consideration, were called "*causes of indistinctness.*"

Let those conditions now be reversed. Let the dimensions of the picture and of the objects represented[89] be such that the spectator may contemplate the work at the distance of two or three feet (or whatever distance may be requisite to insure most distinct vision). Let the picture be opposite the eye. Let the light be altogether adapted. And let the means of representation be oil-painting, the resources of which are all-sufficient for complete imitation.

88 From the scarcity of the works of this great artist, Mengs hesitates to believe that he was the inventor of the deep and glowing style of colour which his Italian eulogists attribute to him; the latter are, however, safer guides. The early pictures of Titian, and the works of Sebastian del Piombo, especially his portraits, attest the influence of Giorgione.

89 A small picture may contain portions of large or even colossal figures, in which case the distance of the spectator from the work is no longer regulated by the dimensions of the frame, but by those of the objects represented. A distance corresponding with the average limits of most distinct vision is here purposely assumed.

Consequences in style.

On the former principle these conditions may be called *causes of distinctness.* They are compatible with, and therefore invite the introduction of, all (agreeable) qualities which in nature can be appreciated only by near inspection. Such qualities now become characteristic of the style, for the above external conditions—involving a just adaptation of technical means, not only permit, but require that every excellence which was inadmissable or unattainable under other circumstances, should now assert its claims. On the same principle, provided the work can be seen with perfect convenience, the means before employed to counteract indistinctness may now be thrown aside—not merely as unnecessary, but because they may interfere with the complete representation of a new order of facts. These appear to be the general principles of the school of the Netherlands, especially in subjects of figures. The leading qualities which are the result may be thus enumerated.

The assumed near point of view, permits and invites the introduction of a large proportion of low tones, all the gradations of which are now appreciable. These are rendered luminous by intenser but still transparent shades and acquire richness from the scarcity of strong light. Accidents of light—not excepting sun-light, are admissable, and often even desirable; they are no longer in danger of interfering with the intelligible representation of form and colour, and may be necessary to give that degree of interest which the subject cannot always command.

The employment of perspective and foreshortening is unrestricted; the last appears to be avoided in no case in which it would be intelligible in nature. Varieties in the place or "position" of objects are especially sought in depth.

An assemblage of broken, harmonious, and nameless hues is next to be remarked, among which the slightest approach to what is called positive colour is effective. This sobriety has nevertheless the effect (with occasional exceptions in the school) of giving a predominant impression of warmth, and of thus vindicating the general character of colour as distinguished from mere chiaro-scuro.

The varieties of sharpness and softness in the boundaries of forms and in their internal markings, must ever exist where there is a background and light and shade; the relation between them is therefore the same as on a larger scale, but the extreme diminution of figures in cabinet pictures generally induces utmost precision in the sharper parts. Lastly, where each object may be discerned without difficulty, yet by means of delicate gradations of light can keep its place and thus be easily intelligible, details may be copious and forms altogether individual. Thus is again furnished the link between appropriate technical means and the choice of incidents, and hence the predilection with the masters of this style for familiar and even trivial circumstances. On this last point it is however to be remarked, that where so much judgment and well-directed skill are present in the work, our respect is commanded even by the unpretending nature of the subjects; and where these are not offensive, they can hardly be said to diminish the satisfaction of the spectator who is alive to the higher objects of the artist. A greater danger to which this style is liable (in finished pictures where human actors form the subject), is that of making the accessories and inanimate objects truer to nature than the representation of life. This defect is, however, avoided, even in elaborate works, by the best masters of the school.

To conclude; the resources, whether abundant or limited, of the imitative arts are, in relation to nature, necessarily incomplete; but it appears that, in the best examples, the very means employed to compensate for their incompleteness are, in each case, the source of a characteristic perfection and the foundation of a specific style. As it is with the arts compared with each other, so it is with the various applications of a given art; the methods employed to correct the incompleteness or indistinctness which may be the result of particular conditions are, in the works of the great masters, the cause of excellences not attainable, to the same extent, by any other means. In the instance last mentioned—the school of the Netherlands—it is apparent that no indirect contrivances or conventions are necessary to counteract the effects of indistinctness; on the contrary, all that would be indistinct in other modes of representation is here admissible with scarcely any restriction. The incompleteness overcome, which is here the cause of peculiar attractions, therefore resides solely in the conditions and imperfections in the art itself, which, on near inspection, are in greater danger of being remembered. These are a flat surface and material pigments; and these are precisely the circumstances which, by the skill of the artists in the works referred to, are forgotten by the spectator. The consequences of the difficulty overcome are, as usual, among the characteristic perfections of the style.

The two extremes of "external conditions" and their corresponding styles have been here chiefly considered. The intermediate modes and combinations are innumerable; but in considering the question to what extent and in what respects the extremes of style may be compatible with each other, it will appear, on a review of what has been stated, that the grander view of nature and of the technical means fitted to represent it may be satisfactory in reduced dimensions in the department of form rather than in those of colour and light-and-shade; and that, on the other hand, the combination of the usual characteristics of small pictures with large dimensions, if possible in light-and-shade and colour, is impossible in form. The last-named attribute being the indispensable medium of the artists' conceptions, it follows that the interchange of subjects fitted respectively for the two styles can only be admissible as regards the treatment of grand subjects in small dimensions, and even then at the risk of the conventions of the grander style being too apparent.

ON THE QUALITY OF LIME PRESERVED FOR FRESCO PAINTING.

By Professor Faraday.

Led by the statement that the keeping of the lime in a slaked condition for a couple of years is a great advantage to it, I took some specimens from the stores which have been so laid up at the Houses of Parliament, for the purpose of examining them in this respect. It appears to me that this lime (which is in a state of paste) is in a very soft and smooth condition in comparision with what would probably be the condition of the lime recently slaked; a condition which seems to be due to its thorough disintegration as a mass, and its separation particle from particle. On analysing it I found that it contained a little carbonic acid, but not much; for in 100 parts of the dry substance there were but 5¼ parts of carbonic acid; these 100 parts, therefore, would contain 88 parts of quick or uncarbonated lime, and 12 parts of carbonated lime, which considering the processes of burning, carrying, slaking, &c., that it had to go through, and the necessary time of exposure to air before it was laid up in store, is a very small proportion. I do not believe that the lime, which is more than 4 inches in, from the exterior, has received any portion of carbonic acid during the two years of its inhumation.

In respect of the effect of keeping lime for a time, I am led to think, without however having formed any strong opinion on the subject, that the benefit is due to the fine texture which it gradually acquires; and as there is no doubt that if two surfaces were prepared, the one with fine sand and lime in particles comparatively coarse, and the other with the same kind of sand and lime in particles comparatively far more perfectly divided, that these two would act very differently both as to the access of carbonic acid from the atmosphere and the transition of lime dissolved in the moisture of the mass from the interior towards the surface; so there is every reason to expect that there would be a difference in the degree of action upon the colours at that surface, and also in the time at which that action would come to a close.

WOODCROFT'S SCREW PROPELLER.

WOODCROFT *v.* SMITH.

The Judicial Committee of the Privy Council met March 11, Lord Brougham, Dr. Lushington, the Duke of Buccleuch, and Lord Cottenham being the members present, to decide upon an application for the extension of his patent made by Mr. Woodcroft, the inventor of a particular form of screw propeller.

Mr. Jervis appeared to support the application; and the Solicitor-General, besides watching the proceedings on behalf of the Crown, appeared in opposition on behalf of Mr. Smith and the Ship Propelling Company, who have adopted his patent.

Mr. Jervis, in stating the case for his client, said, that the invention for which a renewal of his patent right to which application was now made, differed entirely from every other kind of propelling screw in existence. It was formed on the principle of a spiral, represented by the winding of a circular line round a cylinder. The patent was granted in March 1832, and he now applied to their Lordships for an extension. The history of patents for screw propellers (of which he enumerated the advantages) was as follows:—In 1794 Mr. Littleton had taken out the first patent for an invention of that kind, which he proposed working by hand with the capstan, and which was to be either partially or totally immersed in the water, according to circumstances. The next patent for a screw was Mr. Shorter's, taken out in July, 1800. It consisted of the two vanes of a smoke-jack, not submerged, and adapting itself to the movement of the vessel by a universal joint. In 1815 Mr. Trevethic proposed the Archimedean or fixed screw, working in a cylinder. In July 1816, Mr. Millington got a patent for the application of a smoke jack placed beyond the rudder, and worked with the universal joint. In February, 1825, Mr. Perkins patented an invention for having two vanes, working in opposite directions, placed at the side of the rudder. In 1829, Mr. Commeraux patented a perfect one-turn screw fixed parallel to the keel, and held by a stage erected for that purpose beyond the rudder. The date of Mr. Woodcroft's patent was in March, 1832, and the difference between his spiral and the screw of his predecessors was, that whereas the former consisted of a straight line coiled round a cylinder, the latter was made by a circular line so coiled round. The effect of this invention has been to economize the power of the engine, to destroy the vibration, and to produce a greater speed with fewer revolutions. If a spiral worm was coiled round a cylinder, the angle given thereby would decrease, and the "pitch" therefore increased throughout the length of the shaft. Mr. Woodcroft, in his specification, proposed applying this "spiral" in different parts of the ship, and amongst other places before the rudder-post, by cutting away a part of the hull. Mr. Smith's patent, which was on the application of a perfect screw of one turn placed in the centre of the dead wood, was taken out in May, 1836. In 1837 Mr. Ericson patented an invention which differed from that of Mr. Perkins only in being submerged and placed behind the rudder. In 1838, it being ascertained that a perfect screw of one or two turns could not be worked by the obstruction of the back water, Mr. Lowe took out a patent for cutting the screw into arms or blades, which worked between the rudder and the stern-post. In April, 1839, Mr. Smith entered a memorandum of disclaimer, by which he stated that he found that a screw of two turns would not do, that the true principle was to take two half turns of a screw planted in the centre of the "dead wood." After explaining the evidence that he had to produce as to the usefulness of Mr. Woodcroft's invention, Mr. Jervis concluded—Having expended 1,200*l.* and upwards in pushing his invention, and having only received in return about 430*l.*, Mr. Woodcroft was entitled to such a renewal of his patent as would enable him to remunerate himself, not only for capital laid out, but for the time and talent which he had spent upon it. Mr. Woodcroft had made several other inventions, and in applying for a renewal of his patent, he proposed introducing an improvement on the original plan, by which to alter at pleasure the variations in the "pitches."

Mr. Carpmael stated that he had studied the subject of the screw propeller for several years. In the use of ordinary screws, the water was put in motion by the first part of the screw, and being of the speed of the second part of the screw, choked the screw. The advantage of this screw was that the second part was so constructed as to outstrip the motion of the water, so that the instrument was an operative one, whatever might be its length. All other screws consisted of a straight line wound round a cylinder, but that of Mr. Woodcroft was a circle, or segment of it, wound round a cylinder. Tredgold, in his work on propulsion, proposed that the screw should go on with a decreasing angle on an increasing pitch, but he stated nothing about a circle wound round a cylinder, which was Mr. Woodcroft's principle.

Cross-examined by the Solicitor General.—Mr. Commeraux's patent was a spiral by language, but a screw by description. The word "spiral" or "screw" did not truly designate the distinction. The word "helix" was used at present. He had seen the screw of Mr. Woodcroft in a vessel at Bristol, which had come in from sea about three years ago. With that exception he had never seen it in use. He had never known a screw used practically till the time of the Archimedes, in 1839 and 1840. From that time the use of the screw had increased greatly, both in the Royal and mercantile navy. The screw he saw at Bristol was only one fourth of a convolution, and a three-threaded screw. In practice it was called the one-eighth of a convolution. He had never seen the ordinary screw in operation of more than one convolution; but as far as his experience went it would not work. He was satisfied that Mr. Woodcroft's spiral would work with more than one convolution. The varying angle would, he thought, operate all through. The spiral was between the stern-post and the rudder-post, raised for the purpose. Smith's patent was placed in the dead wood. Woodcroft's was not technically a spiral, because it did not run up to a point.

Mr. S. Slaughter said he had built two vessels fitted up with Mr. Woodcroft's "spiral." He had tried other screws in the vessel before Mr. Woodcroft's, and he greatly preferred the latter.

Cross-examined by the Solicitor-General.—The other screws he had tried were not under any patent, and had varied from one-fourth to one-tenth of a convolution. He tried nine screws of varying diameter and the same pitch. Being dissatisfied he tried an increasing pitch and found the advantage of it. He had thus accidentally stumbled on Mr. Woodcroft's invention, and finding that, he applied for a license. With Mr. Woodcroft's he had attained a speed of 14 miles an hour, while with others he had only secured a speed of seven or eight miles an hour. In the one case the water "slipped" off the blades, and in the other it did not.

Mr. Murray, assistant-engineer to the Admiralty, said that he could speak to two trials, one on the 18th of April last, and the other on the 18th of March, in which the relative merits of Mr. Smith's and Mr. Woodcroft's invention had been attested. With that of the former the results were as follows:—With the engine giving 26·28 strokes the rate of speed was 8·18 knots, the slip being 3·143, or 27·758 per cent., and the revolution per minute 104.34. With that of the latter the results were—with the engine giving 24·152 strokes a revolution per minute of 95·99, a speed of 8·159 knots and a slip of 2·155, or 23·562 per cent. The result exhibited in Mr. Woodcroft's favour a speed nearly as great, with less power of the engine, and much less slip. If the facts which he had stated were reduced, a difference would be shown of one-sixth of a knot per hour in favour of Mr. Woodcroft. He was aware that by other experiments Mr. Smith's screw had attained a greater velocity.

Mr. Cowper, an engineer, said, that the invention was a new and very ingenious one. He illustrated its effect by an experiment on the air with tin blades modelled after Mr. Woodcroft's screw, and which when spun rapidly round on an axis by a piece of twine, as a top is spun by a boy, flew up with great force to the ceiling. When the side was reversed, and the experiment repeated, the model was not moved from the axis it revolved on.

The Solicitor-General submitted that the present was no case of a useful invention at all. There was nothing new in the idea of using a screw for propelling vessels, as it had been in existence as long ago as 1794. It was Mr. Smith's discovery that the screw should be placed in the centre of the dead wood which first led to its practical utility. When the screw was so placed and reduced to between one-fourth and one-eighth of a convolution all other points with regard to its construction became immaterial. Before Mr. Smith's invention the screw was placed in unsuitable parts of the vessel, and none of them had ever succeeded. The Solicitor-General then proceeded to explain, with reference to the models produced in court, that it was only by adopting Mr. Smith's discovery and inserting the screw in the dead wood that Mr. Woodcroft had succeeded in making a practical application of his patent. He read an extract from the specification of the latter gentleman, the strongest point in which was as follows:—"The spiral propeller may also be placed under the stern of the vessel, as seen in figures 5 and 6, where a part of the hull is removed." The improvement claimed by him had nothing to do with the position, but was one in reference to an increasing angle. At the time when Mr. Woodcroft took out his patent it was no improvement at all, for want of the discovery that it should be placed in the dead wood.

Lord Brougham.—But it is now beyond a doubt that some steamers may have no "dead wood" at all.

The Soliciter-General.—Practically it might be so in the case of a Dutch built vessel, but not one for steam communication. In all vessels there was but one stern-post, and it was playing with language to introduce the terms which had been used in the evidence. He should refer to Mr. Woodcroft's specification hereafter, but in the mean time he would ask if the space filled by Mr. Woodcroft's screw were not so occupied, would it not be the "dead wood." If so, then Mr. Woodcroft's screw was inserted in the dead wood. In his drawing there was no continuation of the keel, but an undue prolongation of the deck, and a stern-post to which the rudder was attached. No particular ratio of angular increase or decrease was claimed by Mr. Woodcroft, and Mr. Commeraux had already discovered the principle. In the patent of the latter the term "spiral" was used, and in the drawing the increasing angle was clearly marked. The convolutions in the drawing were as three to two.

Mr. Cowper was here recalled, and stated that there was no intimation of an increased pitch in the drawing, even taking into account the word spiral in the specification.

The Solicitor-General then gave up that point, and proceeded to argue that as Mr. Woodcroft had in his specification only provided for one convolution or more, and as there was only evidence of its answering for one-eighth of a convolution, there was no direction in the specification which would guide a workman to the only form of the invention which had practically been found to answer.

Lord Brougham.—The drawing No. 12 shows only one-eighth of a convolution, being exactly what is now used. His claim is quite general.

The Solicitor-General.—Mr. Carpmael had stated that the spiral would work with any number of convolutions, but notwithstanding the amount of experience on the subject now, not more than one-quarter of a revolution had in any screw been found to answer. After 14 years' opportunity for experiment, it had been so, and the *onus probandi* therefore lay on Mr. Woodcroft, for showing that the spiral would work at more than one revolution.

Lord Brougham delivered the judgment. In all cases where there was a disputed right as to patent, and where the validity of the patent might come into question, there were two things to be considered. The first was whether the case to prove the invalidity of the patent was so clear as to remove all ordinary doubt; the second was whether the case was so doubtful that that Court would rather retire from its consideration and not decide it. In the former case they would not grant the extension, because they did not see the merits, and because they would not put the opposing parties to the vexatious process of bringing their *scire facias* in the law courts. But where the matter was doubtful—where conflicting evidence and questions of law equally arose, that Court would not refuse the discretionary power vested in them by Parliament merely because it was also a case in which the validity of the patent was contested. The present case came under the first principle he had stated. There was nothing to make it clear that the patent should not be sustained until they took away the merit of the invention. If the patent turned out to be invalid, it would only be the extension of such a patent for so many years. Now, as to the merits in this case there could be no doubt. His Lordship gave it as his own opinion on a scientific point, that Mr. Woodcroft's invention was a most ingenious application of mathematical principles to mechanical ends, and he commented on the evidence which had been adduced on the subject. It was not enough to object that the patent had been long in coming into operation, for the steam-engine, and many other discoveries, were open to the same observation. All his time, his ingenuity, and his labour had probably been exhausted by Mr. Woodcroft on this work. They had every reason to believe that he would be for the next few years in happier circumstances, and more likely to receive compensation. On the grounds he had stated, their Lordships were of opinion that a period of six years should be given by way of extension to the petitioner. What he had said was without reference to Mr. Smith's invention, which might be a most ingenious one.

The Skew Arch an Old Invention.—"Now visiting the Alcazar (cathedral at Seville), but first observed a singular Moorish skew arch, in a narrow street leading from the cathedral to the Puerta de Xeres; it proves that the Moors practised this now assumed modern invention at least eight centuries ago."—*Ford's Spain.*

THE BOODROOM MARBLES.

For the following communication from Boodroom, Asia Minor, we are indebted to a correspondent of the *Times*.

Our arrival at this once celebrated place, anciently called the city of Halicarnassus, is caused by a request from his Excellency Sir Stratford Canning, the Minister at Constantinople, to remove and receive on board for conveyance to England some ancient marbles, supposed to be a part of the tomb of Mausolus, erected by Artemisia to the memory of her husband, and which was, in the days of the kings of Caria, considered as one of the seven wonders of the world. The monument, in question was, no doubt, a mass of unusual splendour, and from this magnificent sepulchre tombs and the like edifices received their names; it was built by four different architects—Scopas erected the east side, Timothens the south, Leochares the west, Brucis the north. Pithis was also employed in raising a pyramid over this stately superstructure, and the top was adorned by a chariot with four horses; the expense was immense, and called forth the remark made by the philosopher Anaxagoras, when he saw it, "How much money changed into stones."

The marbles were found inside the fortress, and built into the ramparts, and counterscarp and bastions, at various heights from the ground, varying from 40 feet to 12 feet; are of considerable size, being from 7 feet by 5 feet, and of great thickness, varying from 25 to 46 cwt., and 14 in number. This fortress withstood many sieges, especially the one maintained against Alexander the Great, under Memna, and another during the time of the knights of Malta and Rhodes. It is now a Turkish castle, miserably provided with the munitions of war, and bearing striking evidence of the state of Turkish command. Three of the friezes were outside facing the north, one was embedded under a high wall on the left side of the second entrance, three were under the drawbridge leading to the citadel, three more were taken from an outer wall of a moat or trench; two from the right of a wall in the fourth portal, and two from the south-east wall. They were thickly coated with whitewash to correspond with the rest of this stronghold of chivalrous knights, and the greater part resisted, for some time, the impression tried to be made npon them in loosening the brickwork tor their extraction. It may here be mentioned, that the citadel of Boodroom, as it is called, has, on its various walls, ramparts, and bastions, many shields in marble, and near to every one of the antiquities were specimens of the same. No doubt they were considered by the holders as ornaments to their heraldic devices, and their position evidently bespoke that they were so placed as a commemoration of some gallant achievement of the warrior who defended that particular spot. In the inside of the largest tower there appeared one with the figure of St. George and the Dragon, having on each of its sides nine lesser shields, and over the first gate of the drawbridge one betokened that the knight had served in Palestine, bearing underneath the following inscription:—

"I. H. S.
"Salve, nos, Domine vigilantes;
"Nisi Dominus custodierit civitatem
"Frustra vigilet qui custodit."

Leaving, however, these mementos of peculiar interest, it may be mentioned that the figures on the marbles are in a very masterly style. The majority of them are sadly defaced by time, weather, and lime; from their character they are evidently meant as a picture of the wars of the "Amazons;" a few are in a state of preservation, and present to the eye a rare specimen of the sculpture of the age in which they were executed; some pourtray women stricken down by the ruthless hand of the warrior, and their subdued bodies are exquisitely chiselled. But to illustrate this remark, there is one which cannot fail to impress the spectator, and which I think stands pre-eminent—it is the death of a woman by the hand of a man, stretched on the ground, with her head fallen on the left arm, the right hand clenching the earth in the last struggle for life, her conqueror, with head bent and shield before his breast, stands looking with peculiar ferocity on the bloody deed he has committed, whilst an Amazon, with outstretched body and uplifted arms, appears in the act of wreaking vengeance on him who has slain one of her sex.

The village of Boodroom, for it cannot be called a town, is a specimen of Turkish indolence, and were it not for its ancient site, would offer little pleasure to the visitor. There are some fine remains of what the city of Halicarnassus was, on a hill, besides what was most likely an amphitheatre; and though many of its massive stones and marble seats lie scattered in the grass and rank vegetation with which it is overgrown, still there is a sufficient perfectness to dénote that 6,000 people could have witnessed the scenes therein enacted. On a summit at a short distance from this spot are several catacombs, containing chambers or vaults for their dead, some were sealed by stone slabs, and so firmly, as to resist an iron crowbar; one of them was found to contain nearly 40 lachrymatories. These chambers of death have a very curious appearance from the entrance of the harbour, and are seldom visited either by Greek or Turk. About a mile in the country stands in tottering form what was once a gateway, but which is in a very ruinous state, and not far from this place are several small arched buildings, near which must have been an entrance to the city, as several parts of the wall can be traced through the rich olive groves. Adjoining, under the wide spreading branches of a tulip tree, is a sarcophagus, apparently of great antiquity. Time and [illegible] destroyed its sculpture. In another orchard [illegible] piece of a temple, much decayed. Several [illegible]

it, and the pillars are in a very tottering condition. There are about 2,000 houses in Boodroom, inhabited by Turks and Greeks. The soil is rich, but in lieu of green pastures, unwholesome weeds spring up before the eye, proving how much given to indolent habits the Turks are, how they manage to sustain life cannot be told. There is the appearance of their cultivating the olive, fig and almond trees, but even these require but little manual assistance. Some coins of ancient date were obtained; sickness and disease appear in almost every family, and some, from want of medical assistance, were found to be beyond human skill.

Thanks to Sir Stratford Canning, England may now congratulate herself on possessing some of the finest specimens of ancient sculpture in existence; for although those in the interior have been guarded with such jealousy by the Turks, that no eye, save those of the officers of the Siren, have ever been set on them, those on the sea bastion have been visited by celebrated travellers, and pronounced to be little inferior to those of the Parthenon.

REPORT OF EXPERIMENTS ON GUNPOWDER, MADE AT WASHINGTON ARSENAL, IN 1843 & 1844.

By Captain Alfred Mordecai, of the Ordnance Department.

This Report embodies the results of many thousands of accurate experiments made by Capt. Mordecai, under government authority, with instruments constructed in such a manner as to ensure perfect accuracy. Having had the satisfaction of inspecting the instruments, and of hearing from Capt. Mordecai an account of the methods of experimenting, we can speak of them with the greater certainty. The force of gunpowder, since the time of Hutton and the French experimenters, has been calculated by means of the *balistic pendulum* and of a *gun pendulum*. The *gun* (in these experiments a twenty-four and a thirty-two pounder) is suspended in an iron frame, hung on knife edges of hardened steel, like a balance beam, the whole supported (a load of 10,500 lb.) on massive stone pillars. The recoil is measured on a limb of brass, having a curve, of which the frame work and the gun are the radius, and graduated to read to seconds by means of a vernier which is moved by the recoil, and retained at the point of greatest vibration by a slight spring. When the gun is adjusted and at rest, its axis is a horizontal line, and the vernier stands at zero on the scale.

At a distance of only fifty-five feet (between the centres), is inserted the *pendulum block* for receiving the shot and measuring its velocity. This *pendulum* is a counterpart to the gun, as regards its mode of suspension and motion, which is also measured in like manner on a graduated arc. This "*block*" as it is called, resembles a mortar or wide howitzer, with a bore of four and a half feet deep and fifteen inches calibre, and filled with leathern bags of sand, and a bedding of lead. This block, the frame and counterpoise weights, weighed 9,358 lbs., and was suspended so as to hang when at rest, with its axis perfectly in one and the same line as the axis of the gun. When prepared for use, the aperture of the pendulum block was covered by a sheet of lead, which served to make the deviation of the ball from a right line, by the hole which was pierced in it. This deviation was found to be very slight.

It seems, to a person unaccustomed to such experiments, a rather daring attempt to fire a thirty-two pound shot, at the distance of only 50 feet, in the mouth of another gun. But that velocity which, left unrestrained, would serve to carry the shot for miles, is in this apparatus restrained within the range of a few feet, and imparts only a moderate motion on the great mass of matter on which it impinges, which can be wholly and accurately estimated. Capt. Mordecai remarks, that "an observer, placed in such a position as to see the face of the block unobscured by the smoke of the gun, perceives, at the moment of impact, a circle of *reddish white flame* surrounding the hole made by the ball." He supposes "that this flame may be produced by the combustion of minute particles of iron and lead ignited by friction." He further remarks, that "in firing a thirty-two pound ball into the pendulum block with a charge of eight pounds, the sand immediately before the ball was compressed into a solid mass, forming an imperfect sandstone sufficiently firm to bear handling. A specimen is still preserved in that state, after a lapse of more than eighteen months." This sand, when examined, was found quite free from any calcareous cement. An apparatus of quite similar structure, on a proporsionate scale, was used for muskets. In these experiments powder from a great number of manufactories, and of great variety of composition, grain, and finish, was tested. The elements for calculating the strength of gunpowder, obtained by these experiments, were resolved by the formulæ of Hutton and those which more recently have been employed by the French at Metz. This portion of the labour is performed with the accuracy and skill which characterize all the highly educated officers from West Point Academy. Capt. Mordecai concludes from the results of his experiments, that the only reliable mode of proving the strength of gunpowder is to test it, with service charges, in the arms for which it is designed; for which purpose the balistic pendulums are perfectly adapted.

[illegible] pounder gun, new cannon powder should give, with a [illegible] of the ball, an initial velocity of not less [illegible] ball of medium size and windage.

The initial velocity of the musket ball, of 0·05 in windage, with a charge of one hundred and twenty grains, should be

With new musket powder not less than	1,500 feet.
" " rifle " " "	1,600
" fine sporting " " "	1,800

The common eprouvettes are of no value as instruments for determining the relative force of different kinds of gunpowder.

The proportions used in making our best powder, 76.14.10, and the English 75.15.10, appear to be favourable to the strength of powder. The best mode of manufacture is in what is called the cylinder mills under heavy rollers, and this process alone is considered capable of making good sporting powder. The English have employed this process for fifty years, but the French still use the old method, by stamping or pounding. The "*gravimetric density*" should not be less than 850, nor more than 920. The charge for cannon for all ordinary purposes should be one-fourth. No purpose, even breaching a battery, requires more than one-third the weight of the ball. For small arms the following charges are proposed; for the percussion musket, 110 grains; the percussion rifle, 75 grains; the percussion pistol, 30 grains of rifle powder. It is proposed that musket and rifle balls should be made by compression, instead of casting, as at present.—*Silliman's Amer. Journal.*

REGISTER OF NEW PATENTS.

If additional information be required respecting any patent, it may be obtained at the office of this Journal.

FIRE ALARUM.

Francis Taylor, of Romsey, in the county of Hants, surgeon, for "*Improvements in giving alarum in case of fire, and in extinguishing fire.*"—Granted August 6, 1845; Enrolled February 5, 1846.

Fig. 1 shows a transverse section, and fig. 2 a front elevation of an apparatus for giving alarum in case of fire; *a* is a tube of glass having a bulb or enlargement about the middle part thereof, this tube which is to be filled with mercury and hermetically sealed at both ends is supported in

Fig. 1.

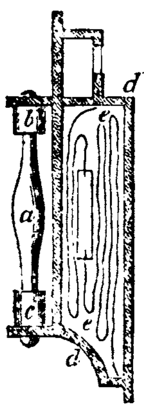


Fig. 2.

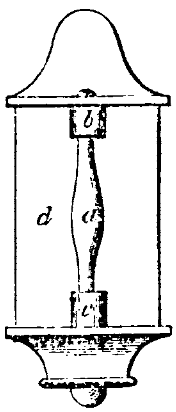
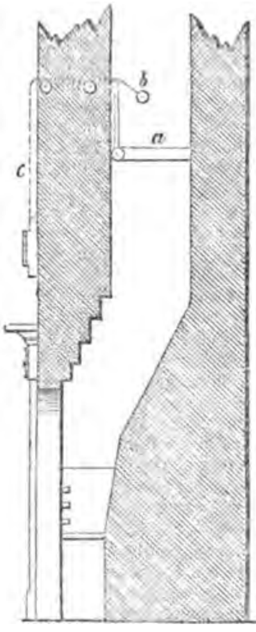


Fig. 3.



two brass sockets; *b c, d d*, is a brass or other metal box composed of two parts, the front part *d* being attached to the back part by the strength of the glass tube; *e e* are two pieces of tape of about half a yard each, more or less; one end is attached to the upper and lower, or front and back part of the box, the opposite ends being joined to a detonating packet containing some explosive mixture. This apparatus may be hung up in any part of a room most likely to give immediate alarum in case of fire, which fire on attaining a few degrees of heat above the temperature of the room would expand the mercury, and have the effect of bursting the tube, and thereby let fall the front part of the box, and cause the explosion of the detonating mixture, which would give the alarum required. The specification shows several modifications of this principle; it also shows the application of one for stopping the draft of the chimney, so as to impede the progress of the fire. Fig. 3 is a transverse section of the chimney, having fixed therein a few feet from the bottom, a rectangular frame *a*, and plate *b*, which plate is kept in a vertical position by a chain *c* passing over two small pullies, the opposite or lower ends of this chain are attached to an apparatus constructed on the same principle as that above described, fixed over the mantle-piece, which in case of fire would burst as aforesaid, and let fall the plate *b*, and have the effect of stopping the draft, thereby impeding the progress of the fire.

COPPER ORES.

Frederick Bankart, of Champion Park, Denmark Hill, in the county of Surrey, Gent., for "*certain improvements in treating certain metallic ores, and refining the products therefrom.*"—Granted August 7, 1845; Enrolled February 7, 1846.

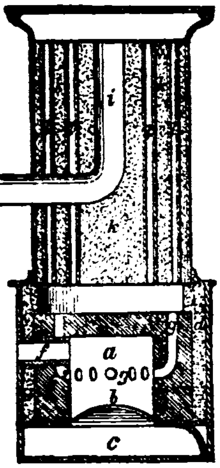
The improvements relate to ores containing copper, whether combined with sulphur or not; and consist in mixing the different ores in such a manner, that those which contain sulphur in excess may compensate for the deficiency of sulphur in the other ores, and submitting the ores so adjusted to successive roastings and lixiviations, whereby a solution of sulphate of copper is obtained, from which the copper may be precipitated in a refined metallic state, which is done in the following manner:—The copper ore is first reduced to powder, and the relative proportions of sulphur and copper which it contains are ascertained by analysis; then if the sulphur bears a less proportion to the copper than one to two, iron pyrites or copper pyrites, also pulverized, are added, in such quantities as will bring it to that proportion. If two or more descriptions of copper ores are to be treated, they must be mixed together in such proportions as will make the sulphur of the mixture bear to the copper at least the proportion of one to two; iron pyrites or copper pyrites being added, where necessary, to ensure that proportion of sulphur. And there must always be a sufficient quantity of sulphur ores for the conversion of the copper into a soluble sulphate, and also to allow for the escape of part of the sulphur during the processes. The copper ore, prepared in this manner, is then submitted to such a degree of heat, in free contact with atmospheric air, as will oxidize the metals not already in a state of oxide, and convert the sulphur into sulphuric acid. For this purpose, a common reverberatory furnace is used, and the ore submitted to a dull red heat, in free contact with the air, until the mixture attains a state of seeming fluidity, and it is retained in that state until the evolution of sulphurous vapour nearly ceases: the whole of the mixture is not put into the furnace at once; but it is divided into several portions, and one portion being put into the furnace, another is added when the first has attained a dull red heat, and so on until the whole has been introduced;—the mixture is frequently stirred during the process. The evolution of sulphurous vapour having ceased, or nearly so, the mixture is removed from the furnace to a vat or pit, and water (or a weak sulphate liquor from a previous lixiviation) applied at about the boiling temperature, and retained at that temperature for some time, by means of injected steam, to ensure the solution of the sulphate of copper. When the sulphate of copper liquor is drawn off from the residual mixture, the latter is mixed with as much iron pyrites or copper pyrites as will supply the requisite proportion of sulphur; the whole is then subjected to a second roasting, and to a second lixiviation; this process of adjusting the proportion of sulphur in the mixture, and roasting and lixiviating, is repeated until the whole of the copper is obtained from the ore. The next process is to precipitate the copper from its sulphate solution; after which it is to be fused, and run into moulds, for sale as fine metallic copper. Various modes of precipitation may be adopted; but the patentee prefers to employ cast or wrought-iron plates, keeping the solution at a temperature of from 120° to 150° Fahr., and as nearly as may be of the same strength, by means of a circulating stream of fresh sulphate solution, which, entering at the top, and being conducted by a pipe downwards, tends, by its greater specific gravity, to displace the lighter solution; the latter, overflowing, is to be returned into the lixiviating vat, to be recharged with sulphate of copper, and this again precipitated, until the refuse liquid becomes a nearly saturated solution of sulphate of iron, when it is set aside to crystallize.

The claim is for mixing of the different ores of copper and iron pyrites in such proportion, according to the quantity of sulphur relatively with the copper which they respectively contain, and adjusting them in such manner as that ores which hold sulphur in excess may compensate others which are wholly or partially deficient in sulphur, and subjecting such mixture to a succession of roastings and lixiviations (the residuum, after each roasting, having the proportion of copper to sulphur adjusted as before), and thereby obtaining a solution of sulphate of copper, whence the copper is obtained, by precipitation, in a refined metallic state.

STOVES.

Charles Searle, of Bath, in the county of Somerset, doctor of medicine, for "*improvements in stoves.*"—Granted August 9, 1845; Enrolled February 9, 1846.

The improvements consist, firstly, in the employment of a heat retaining mass in connection with the fire-chamber, for the heated gases to pass through on their way to the flue, instead of the vessels now in use as the connecting medium between the fire-chamber and the flue. Secondly, in so constructing the fire-chamber or furnace as to obtain solidity of substance, and isolation from surrounding conducting media as far as may be practicable, with confinement of space or closeness of the fire-chamber; the patentee's object being to absorb and retain as long as possible the heat derived from the combustion of the fuel, to prevent its escape, and to concentrate its operation upon the fuel, in aid of its more perfect combustion.



The annexed figure shows a vertical section of a stove. *a* is the fire-chamber, of fire-bricks, about two inches thick, of a cylindrical shape (or either conical, square, or polygonal, if preferred), and the top is perforated with numerous holes, from ⅛th to ¼th of an inch in diameter, on the side, as shown at *g*, for the escape of the gases from the fire; at the bottom is an iron grating *b*, and beneath it an ash-pit or chamber *c*. *d* is a packing of sand or clay, between the fire-chamber and the outer cylindrical case of iron *e*, to prevent the radiation of heat at that part; and *f* is a door-way or opening for the introduction of fuel. The smoke and gases, in their escape from the fire-chamber, having to pass through the apertures in the top or side (which in time becomes red-hot), are consumed or intensely heated. The combustion is carried on in the lower part of the chamber; the upper part serving as a magazine or store of fuel.

Besides these methods of constructing fire-chambers, they may be composed of two vessels of a cylindrical or other shape, one within the other; the gases from the fire being allowed to escape between the two by openings in the side of the inner one, which contains the fuel, and is closed at the top; or the current of gases may be made to descend through the body of the ignited fuel and grate, and then pass up between the two vessels, by admitting air above the fuel, instead of from below.

The heat retainer of the stove, through which the gases have to pass in their course to the flue *i* is made of slabs or discs of burnt clay or brick, fitting closely within the casing or body of the stove; or the retaining mass may be composed of any number of smaller parts, with intervening spaces for the passage of the gases, instead of the perforations above-mentioned. Or slabs of soft stone or brick, of any shape, may be employed; the gases either passing through openings in the slabs, or circulating between them. Or the body of the stove may consist of a vessel of iron or other material, filled and packed with sand, clay, or other suitable substance, as represented at *k*, through which tubes of metal or pottery *l*, about an inch in diameter, extend; in this arrangement, as well as when perforated slabs or discs are used, a solid mass, of not less than two feet in sickness, is considered desirable. A series of hollow cones, or cylinders of pottery or brick, might also be arranged one within the other, to act as a heat-retaining mass; the gases passing between them. Or a "tubulated cylinder," filled with tallow, oil, or other fluid possessing a great capacity for caloric, might be employed for the same purpose.

The patentee does not confine his invention to stoves for heating apartments; but proposes to apply it also to apparatus for cooking.

MOTIVE POWER.

Mathew Francois Isoard, of Paris, for "*Improvements in obtaining motive power.*"—Granted August 28th, 1845; Enrolled February 28th, 1846.

This invention consists in the application of the reaction of steam for the purpose of producing rotary motion, and in the peculiar combination of parts forming a rotary engine. Fig. 1 shows a sectional elevation of an

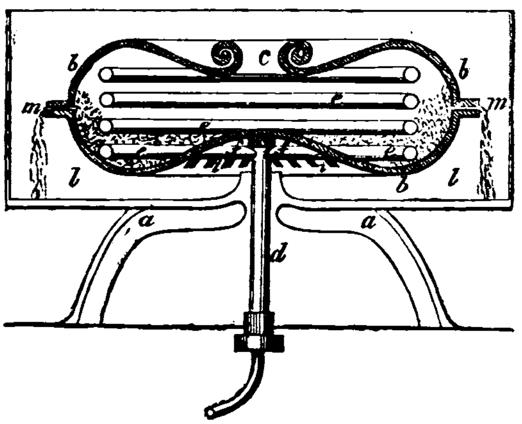


Fig. 1.

engine constructed according to this invention, in which *a* shows a portion of the frame work supporting the engine, which consists of a vessel of the form shown at *b b*, having an opening at *c*; this vessel is supported upon a hollow axis *d*, so as to admit of the same turning freely; *e e* are one, two, or more, coils of pipes, and are made in the form of a single or double threaded screw, depending upon the number of pipes employed. Each of these pipes communicate with the hollow axis *d*, by means of pipes *f f*, and are provided with outlet pipes *g g*, made to pass through

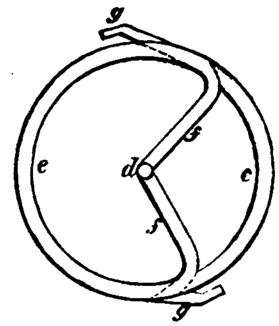


Fig. 2.

the sides of the vessel *b b*, see Fig. 2, which shows a plan of two pipes coiled one within or between the other. *h* (Fig. 1) is a pipe leading from a force pump (worked by the engine), and is intended to supply the pipes *e e* with water. *k k* represents the combustible matter of which the fire is composed, which is lighted within the vessel *b b*, and provided at the lower end with a number of openings, *i i*, for supplying the fire with air. The action of this engine is as follows: the pipes *e e* being filled with water, a fire is lighted within the vessel *b b*, and steam is generated within the pipes *e e*, which is allowed to escape through the outlet pipes *g g*, the reaction of which against the air causes the vessel *b b*, together with the pipes *e e* and hollow axle *d*, to rotate. Upon the hollow axle *d* is keyed a wheel (not shown in the diagram) for the purpose of imparting such motion to the force pump, which supplies the pipes *e e* with water as steam is generated; from such wheel, motion may also be imparted to other machinery intended to be driven by the aforesaid engine. *l l* is the ash-pit which receives the ashes as they fall from the openings *m m*.

IMPROVED CUPOLA FOR MELTING IRON.

Constructed by Messrs. Franklin Townsend, & Co., Albany, N. Y.

This cupola is of the ordinary construction, only being of enlarged dimensions, and made of cast iron. Its diameter at the *tuyères*, when lined with fire brick, is three feet; and its height, from the hearth to the charging door, eleven feet. When charged full, it will contain three tons of pig iron, and is capable of melting upwards of twelve tons at one blast. The air is admitted into the cupola by six tuyères, which are placed about fifteen inches above the hearth, and equidistant on the circumference of the cylinder. To avoid the number of pipes which would be necessary if the air were conducted into the cupola by the usual method, an air chamber is made to surround the cylinder and enclose all the tuyères, and into this the main blast pipe is introduced. An opening is made through the outside of this air chamber, and directly opposite to each tuyère, which, being protected by a plate of glass, allows the *melter* to observe the working of the furnace. This plate of glass is so attached that it can be easily removed, and thus give free entrance to clear the tuyères whenever it may be necessary.

The air is heated by being forced through a number of small pipes, placed in such a manner in the interior of the stalk immediately above and directly over the cylinder of the cupola, that their outside surfaces are exposed to the full action of the waste heat of the furnace. For reason of the difficulty caused by the expansion of the metal when heated, these pipes are required to be of peculiar construction. By this arrangement, the air becomes heated during its passage from the blast reservoir to the tuyères, upwards of 400° Fahrenheit's thermometer.

This cupola has been in operation during the past three months, melting ten tons of iron daily. The iron is *charged* in the shape of *pig* and *scrap* (*sprues, gates, &c.*) in about equal proportions, and is cast into stove-plates, which require that it should be very hot and liquid. The average consumption of coal (Lehigh) in melting this quantity of iron, is 225 lb to the ton of iron, and the rate of melting is from two to three tons per hour. An ordinary cupola, operated with cold blast, consumes upwards of 500 lb. of coal to the ton of iron, and its rate of melting is from one to two tons per hour.

Not having the results of the operation of any hot blast cupola in this country, the comparison of the *working* of this improved cupola with them cannot be given; but its evident superiority to those of England is shown by the following extracts from a report made by M. Dufresnoy, chief engineer of mines:—

"The cupola furnaces at the Tyne Iron Works are operated with heated air. The consumption of coke is 309 lb. to the ton of iron; rate of melting, one ton per hour.

"At Wednesbury, the cupolas are operated with hot blast, and consume

16

287 lb of coke to the ton of iron. Before the adoption of the hot blast, the consumption of coke was 441 lb. to the ton of iron. The same quantity of iron is melted in one-half of the time that was required before the adoption of this process."—*Franklin Journal.*

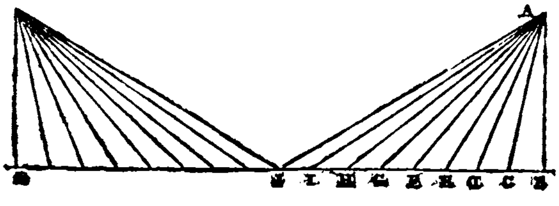
AUST PASSAGE BRIDGE.

(*With an engraving, Plate* V.)

The proposition to build a bridge across the old passage of the Bristol Channel, at Chepstow, has arisen from the intended improved connection of South Wales with England by means of railways, and whatever may be the objects of crossing the Bristol Channel elsewhere, the old passage is unquestionably the point where the nearest junction of South Wales with Bristol, the West of England, and London, can be effected.

In the session of 1845 I recommended, in my evidence upon the South Wales Railway, that this bridge should be constructed with a span of 1,000 feet from pier to pier, and height of 120 feet above high water mark of spring tides. Since then, I have had a correct plan and sections made of the Channel, from which I find it practicable to place the piers on rock foundations, accessible at low water, but at distances of 1,100 feet apart. The bridge will therefore require four spans of this length, and one at each end of nearly 550 feet. In addition to which, another bridge should be built across the Wye, with one span of about 500 feet in length, and one at each end of about 250 feet each. I expressed my opinion in the session of 1845, that the suspension principle adopted at Menai Bridge and elsewhere, would not be sufficiently steady for the Aust Bridge without material improvements in it. I have accordingly, in conjunction with Mr. Francis Bashforth, Fellow of St. John's, Cambridge, designed a bridge for the Aust Passage, which the accompanying engraving represents (see plate V.); the calculations for which are subjoined, for the scrutiny of scientific men, and I have great pleasure in associating my name with Mr. Bashforth's in this work. FRANCIS GILES.

Experience has shown that the instability of suspension bridges is their great defect, whilst they may be made of sufficient strength to bear any load that can ever be placed upon them. To guard against their liability to undulation an arrangement is proposed, so that every part may be always in its proper position to support any heavy weight placed on the roadway. The bars radiating from the tops of the piers are of variable thickness, so that each is capable of sustaining the same weight as when placed at its extremity on the platform (supposed to be a rigid lever moveable about the end). These radiating bars are kept straight and connected together by transverse rods, but the former alone are calculated to sustain the whole of the load, the latter being employed to keep them in their proper position and to ensure the assumed rigidity of the platform. The supporting bars are attached to the platform at equal distances and are passed over the top of the pier (side by side or otherwise). On account of their number the space covered would be considerable, but this would be an advantage as the tendency would be to keep the platform steady. In addition, the main chains are proposed to be connected by rods overhead to within about 20 feet of the roadway. So as to form an immense trussed beam. Let t denote the number of tons that a bar of iron of 1 square inch



section would bear without injury. $AB = h$, $BB = s$, $BC = CD = DE = \&c. = \delta$. Let AF be the r the bar from AB. Then $BF = r\delta$ w, the weight supported by AF at F on the platform. k = weight of a bar of iron 1 foot long and 1 square inch section. n = number of bars between B and J.

$$\text{The tension of AF} = w\frac{AF}{AB} = w\frac{AF}{h}$$

$$\text{Weight of AF} = \kappa\frac{\text{tension of AF}}{t} \times AF = \frac{\kappa w}{t}\frac{AF^2}{h} = \frac{\kappa w h}{t}\left(1 + \frac{r^2\delta^2}{h^2}\right)$$

and giving to r successively the values 1, 2, 3——n we get the necessary weight of each bar, and four times their sum will be equal the weight of the supporting bars between the piers = W suppose

$$\therefore W = 4 \times \frac{\kappa w h}{t}\left\{n + \frac{\delta^2}{h^2}\left(1^2+2^2+3^2+\ldots n^2\right)\right\}$$

$$= \frac{\kappa w h n}{t}\left\{1 + \frac{n^2\delta^2}{h^2}\left(\frac{1}{3}+\frac{1}{2n}+\frac{1}{6n^2}\right)\right\}$$

But if W be the weight to be supported on the platform when uniformly distributed, $W = 4nw$ and $n\delta = \frac{S}{2}$

$$\therefore W' = \frac{W\kappa h}{t}\left\{1 + \frac{S^2}{4h^2}\left(\frac{1}{3}+\frac{1}{2n}+\frac{1}{6n^2}\right)\right\}$$

It is manifest that W′ cannot be made a minimum by the variation of n, but as n increases W decreases, and the least possible value is given by $n = a$ in which case $W' = \frac{W\kappa h}{t}\left\{1 + \frac{S^2}{12h^2}\right\}$. In this case we should have the bars replaced by a very great number of wires, but there would be no rigidity for preventing the platform being raised in the middle. A bridge so constructed in Scotland was soon destroyed by the wind and replaced by one of the common form. Hence the greatest number of bars must be made use of, consistent with the rigidity of the whole. W′ is also a function of h, the height of the platform above the roadway. Making $\frac{dW'}{dh} = 0$ we find $h = +\frac{S}{2}\sqrt{\frac{1}{3}+\frac{1}{2n}+\frac{1}{6n^2}}$. The positive value of h makes $\frac{d^2W'}{dh^2}$ a positive quantity and $\therefore$ gives the minimum value of W.

But the expense of raising the piers to a height necessary to ensure the minimum quantity of iron being required must be taken into account. Let H denote the height of the roadway above the ground, and x the height of a course of stones on the pier above the platform. Suppose now the cost of any course of stones varies as (height) s, where s is integral or fractional, and also that μ is the expense of a course at height unity from the ground, expressed in terms of a weight of iron of equivalent value.

Expense of the pier above the platform,

$$= \int_0^h \mu\,(H + x)^s\,dx = \frac{\mu}{S+1}\left\{\overline{H+h}^{\,S+1} - H^{S+1}\right\}$$

Hence h must have such a value as makes

$$\frac{\mu}{S+1}\left\{(H+h)^{S+1} - H^{S+1}\right\} + \frac{W\kappa h}{t}\left\{1 + \frac{S^2}{4h^2}\left(\frac{1}{3}+\frac{1}{2n}+\frac{1}{6n^2}\right)\right\} = \text{a min.}$$

It must be remarked that the extremities of the radiating bars would remain in the same straight line for all variations of temperature, provided each bar expanded in proportion to its length. Thus the equation to a straight line is $\rho\cos\theta = a$ (1) If we suppose ρ to receive an increment $\mu\rho$ proportional to its length, the radius vector then becomes $\rho + \mu\rho = \rho'$ (2). (suppose) and eliminating ρ between (1) and (2) we get $\rho'\cos\theta = a(1+\mu)$ ... (3), which is the equation to a straight line, parallel to (1) and at a distance μa. For a span of 900 feet; $a = 90$ feet suppose, and for ordinary changes of the atmospheric temperature

$$\mu = \frac{1}{1800} \therefore \mu a = \frac{90}{1800}\text{ feet} = \frac{12}{20}\text{ inches} = {\cdot}6\text{ inches.}$$

It has been objected that there would be a tendency in the network to "buckle;" this would be perfectly correct in the case of a girder bridge, but there would be no occasion to fear that defect if the proposed plan were properly carried out. For it must be remarked that everything is made subordinate to the radiating bars. The *straight* horizontal rods are intended to insure the rigidity of the platform. When a weight passed over the bridge, the tendency of the supporting bars would be to rotate about the top of the pier, but these *straight* bars acting directly by tension on one side and compression on the other, prevent this, and cannot buckle unless the rods stretch. The bars must be connected so as to admit of adjustments without injury to the strength of the material.

The weight of the material required for the supporting bars on this plan would be from half to two-thirds of that required for the main chains of a catenary of equal strength, but on account of the numerous cross pieces, the saving effected by this plan would not be important, but it is satisfactory to know that suspension bridges may be made much firmer and free from undulation without increasing the cost and adding to the weight to be supported.

RESEARCHES IN HYDRAULICS.

Sir—In Weale's "Quarterly Papers on Engineering" for Michaelmas last, there is an article, "Researches in Hydraulics," by a Mr. Peacocke, in which he attempts to prove the several formulæ of Genieys, Dubuat, Piony, Eytelwein, Dr. Young, and Smeaton, for calculating the discharge of water from pipes, are incorrect, and joins his faith to that of Mr. Provis, whose formula, he *thinks*, might be carried out for a length of pipe of 1,500 feet (!) at least, without any considerable inaccuracy. Ignorant he must be that mains are sometimes three or four miles long, and even more than that. It would be doing Mr. Peacocke and the profession a service, were you to review this in your usual clever style and expose its absurdity.

In Smeaton's Reports, vol. 1, page 231, you will see that by measurement, one of the mains of the Edinburgh Water Works is 4·5 in. diameter, and delivered 21·07 cubic feet per minute. By calculation with Eytelwein's formula he gives 4·49 in. for diameter and 12 feet discharge; and again, vol 3, page 231 (1st edition), the actual velocity from a main of the same Water Works was 1,815 feet per second, whilst the calculated velocity was 1,816 feet per second. I remain, &c.

Macclesfield, March 14th 1846. S. C. S.

[A review of Mr. Peacocke's paper has already appeared in our January number.]

THE BRITISH MUSEUM FACADE.

Sir—The "Idea" shown in the last Number of your Journal would effect so decided an improvement in the façade of our national museum, that it is a thousand pities it did not originate with the architect himself, its adoption being now altogether out of the question, unless it could be made compulsory. Such an important public edifice is a very legitimate subject for public interference; it ought, therefore to be made a matter of consideration whether *something* of the kind at least ought not to be now done. Be such the course or not, it is highly to the credit of your Journal to have shown what might be done to redeem the Museum façade.

I remain, Sir,

London, March 11th, 1846. A Constant Reader.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

February 23.—The successful competitors for the *Prize Medals of the Institute*, for the year 1845, were announced as follows:—

To Mr. T. Worthington, of Manchester, the Medal of the Institute for the best Essay on the History and Manufacture of Bricks.

To Mr. S. J. Nicholl, the Medal of Merit, for his Essay on the same subject.

To Mr. J. F. Wadmore, of Upper Clapton, the Medal of Merit, for a Design for a Royal Chapel.

March 9.—J. B. Papworth, Esq., V.P. in the Chair.

Mr. E. Woodthorpe was elected a Fellow. Amongst the donations announced, was a Medal struck by the Society for the Encouragement of the Industrial Arts in Prussia, in honour of their President, the Chevalier Beuth, presented by the Chevalier Hebeler, who likewise exhibited Herr Ternite's work, "On the Frescoes at Herculaneum and Pompeii."

A portion of the Prize Essay, "*On the History and Manufacture of Bricks*," by Mr. Worthington, was read, and comprised chiefly an account of the earliest recorded instances of the application of brick, both in a crude and burnt state, in the walls and structures of Babylon, Nineveh, Ecbatana, and other cities of Assyria, in China, Egypt, Greece and Italy, involving frequent allusions to the Sacred Writings, and lengthened quotations from Herodotus, Pliny, and other well-known ancient authors, as well as modern travellers.

March 23.—W. Tite, Esq., V.P., in the Chair.

Mr. Poynter, the Honorary Secretary, read a highly interesting and valuable paper on *the Stained Glass in Sainte Chapelle, at Paris.* We must defer this paper until next month, when we propose to give it fully, illustrated with several engravings.

A paper, by Dr. W. Bromet, (accompanied by a drawing,) *descriptive of some moulded bricks*, of various forms, found in the walls of a church, at Sanson-sur-Rille, in Normandy, taken down a few years ago, was read. From the circumstance of these bricks being of ornamental form, and from their being found imbedded as *materiel* in the walls of a building which is mentioned in a book of the year 1210, they are believed to have been portions of the abbey founded at Sanson, in the sixth century, by King Childebert, but destroyed during one of the incursions of the Northmen, in the ninth century. From the pyramidal form of most of these bricks, and the similarity in shape of some to the stones in the Tour-Magne, at Nismes, it is thought probable that they were made after Roman models, if not in Roman times. On the church walls of Ainay, at Lyons, at Tourness, on the Saone, and of Notre Dame du Port, at Clermont,—all nearly of Carlovingian times,—there still exist moulded bricks, geometrically arranged as ornaments; and Dr. Bromet thought it probable, that during Saxon times many of our buildings were adorned with moulded bricks, such as those forming a band on the tower of Sompting Church, in Sussex, and which Rickman deemed to be Saxon, because never seen by him in Normandy or elsewhere. "In conclusion," says Dr. Bromet, "I will venture to express an opinion, that, in no part of the Romanized world could so useful an art as brick-making ever have been lost; although Eginhard tells us to the contrary, and that his master, Charlemagne, re-introduced it from Italy into his French and German dominions.

The Chairman drew attention to the expected arrival in England from Boodroom of a valuable addition to the treasures of ancient sculpture which this country already possesses. The marbles alluded to are generally supposed to have formed a part of the tomb erected by Queen Artemisia to the memory of her husband, Mausolus, though the fact is questioned by Dr. Clarke. Mr. Tite took occasion to express his satisfaction at the success which had attended the efforts of the architects of England, in 1841, to interest the Government in the preservation of these valuable relics, at which time a representation was made by the Institute, to Lord Palmerston, of the importance of rescuing these antiquities from the degradation and destruction to which they were exposed. The suggestion had been received most courteously and acted upon in a way to effect this satisfactory result.

ROYAL SCOTTISH SOCIETY OF ARTS.

February 23, 1846.—Sir George S. Mackenzie, Bart., F.R.S.E., President, in the Chair.

The following communications were made:—

1. *Notice of an Improvement in his Model of a Self-acting method of Throwing the Shuttle in the Common Hand Loom*, &c. By Mr. James Miller, Watchmaker, Perth. In this model an improvement is introduced, calculated, in Mr. Miller's opinion, to prevent the recoil of the shuttle, viz., by interposing a *driver*, as in the common loom. He has also made simple arrangements by which the strength of the driving springs may be tempered or increased at pleasure.

2. *On the applicability of the Electro-Magnetic Bell to the trial of experiments on the Conduction of Sound, especially by Gases.* By George Wilson, M.D., F.R.S.E. The apparatus was exhibited. The object of this paper, and his illustrative experiments, was to show that the Electro-Magnetic Bell is a better and cheaper means of ascertaining the capabilities of different gases to conduct sound than the method of a bell struck by clock-work, as hitherto commonly used. The Electro-Magnetic Bell is much more under command, and we are not troubled with the clock-work running down, and being obliged to remove the receiver of the air-pump to wind it up again. It was exhibited to the Society, by means of the Electro-Magnetic Bell; the difference in the conduction of sound betwixt atmospheric air and hydrogen gas, showing that the latter has greatly less capability to transmit sound. He experimented by placing the bell within the glass receiver of a common air-pump, full of common air, and making the hammer strike the bell by connecting the wire of the temporary magnet with the battery, when the sound of the bell was distinctly heard; and then by exhausting the air from the receiver, and introducing hydrogen gas, and again making the hammer strike the bell, when the sound produced was so weak as to be scarcely audible.

3. *Description and Drawings of an Improved Crank Planing-Machine, and of its advantages over the Common Crank Planing-Machine.* Manufactured by Messrs. Thomas Shanks & Co., Engineers, Johnston, Renfrewshire. This is a very beautiful application of the ellipse to produce alternate quick and slow motion. Two elliptic wheels are made to work into each other, the *driver* working round the one focus, and the *follower* working round the opposite focus of the ellipses, by which means the two ellipses roll upon each other, and always keep in contact. When the driver has its *shorter* lever turned towards the *longer* lever of the follower (to which the crank is fixed), a slow motion is produced, suitable for taking the cut: but when the driver is turned round, and its longer lever becomes opposed to the shorter lever of the follower, a quick motion is produced, thus sending back the planing table very rapidly, so that little time is lost betwixt that and the next cut of the tool.

4. *Description of a Modification and Improvement of the Voltaic or Electro-Chemical Telegraph.* Invented by Mr. R. B. Smith, Lecturer on Chemistry, Blackford. This is an improvement of the Electro-Chemical Telegraph formerly communicated by Mr. Smith. In this telegraph a ribband of cotton or paper, which has been made to pass through a trough filled with a solution of ferro-cyanide of potass, to which has been added a few drops of nitric acid,—is drawn by clock-work, or otherwise over a cylinder of lead, which is in communication with the negative wire of the battery; while there is in communication with the positive wire an impress iron wire, resting immediately on the cotton or paper ribband as it passes over the leaden cylinder. When the circuit is completed by pressing down a key with the finger, the electricity passes along to the impress wire, and a blue coloured mark is printed on the paper, or cloth, caused by the action of the electric fluid decomposing the ferro-cyanide of potass, and forming ferro-cyanide of

iron. If the circuit is closed and broken rapidly, a succession of marks or dots will be printed on the ribband; but if closed for a longer time, and then broken, the marks are longer; so that long spaces, and short spaces, dots, long and short lines, are formed at pleasure. An arrangement of these marks constitutes the Telegraphic Alphabet.

Monday, March 9. John Adie, Esq., F.R.S.E., V.P., in the Chair.
The following communications were made:—

1. "*Description of a Machine for drawing the perfect Egg Oval, and a Method of producing Curvilineal Figures.* Invented by D. R. Hay, Esq., Edinburgh.—A model of the machine was exhibited to the meeting; it will draw correctly the egg form, or oval, as it differs from the ellipse; and also a mode of producing, upon the principle of harmonic ratio, and by a very simple process, a series of curvilineal figures, by which beauty and originality may be imparted to the ornamental works of the architect, and to those of the silversmith, potter, &c., from the most expensive to the humblest product of their respective arts, such as vases, tureens, teapots, cups, &c.; and proved, by specimens executed on a large scale, in presence of the meeting, that, if the most approved works of this kind that have been handed down from the Greeks and Etruscans, were not produced by the same means, his method could produce, with ease and certainty, equal beauty and elegance of design, in endless variety.

2. *A specimen of ornamental Oak Carving*, executed by Mr. John Steel, sen., Edinburgh, was exhibited. It was a very beautiful specimen of Scottish art, exhibiting a number of figures of dead game, &c., from the stag and the heron to the grouse. It was much undercut, some of the figures nearly relieved, and met with general admiration.

3. Some Specimens of the Native useful Arts of New Zealand, and a Specimen of the *Flax Plant* of that country, were exhibited by Mr. W. Wells.—The specimens consisted in various articles of dress, of native manufacture, woven from the native flax, and ornamented in a curious manner with portions of the plant. They form very thick and comfortable outer garments. Some specimens of dyed stuff were also shown; and a specimen of the flax plant, together with the flax produced from it, which, when formed into cordage, was said to bear a considerable strain, provided the strain be equal, but is very apt to snap if a sudden strain be applied; or if a knot be formed on the cord it is apt to break at the knot. It was stated that these bad qualities might result from the imperfect manner in which the flax is prepared, and that they may possibly be removed by skilful preparation of the flax.

SOCIETY OF ARTS, LONDON.

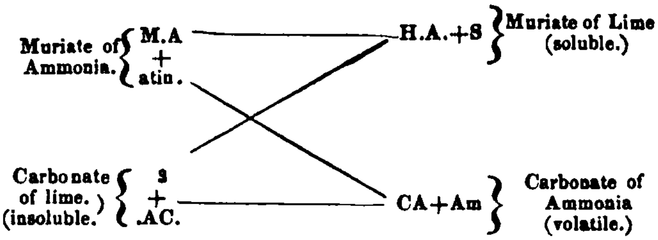
Feb. 25.—W. H. Bodkin, Esq., M. P., V. P. in the Chair.

The following papers was read "*on a new form of Locomotive Steam Engine*," by Mr. T. R. Crampton. The object being to prevent rocking and vibratory motion, and to obtain the advantage of large driving wheels without increasing the height of the centre of gravity. The principal features of the invention are first, the driving wheels are placed at the fire-box end of the boiler, so that the wheels may be made of any height without raising the centre of gravity of the engine, thus a lower centre of gravity is obtained, and also greater stability than is the case in any of the usual forms.

It is also conceived that by placing the driving wheels beyond the extremity of the boiler greater steadiness would be given from the absence of overhanging weight. With these essential changes the remainder of the working parts of the ordinary engine may be maintained without any other alteration in their position.

On the Formation of Incrustations in Steam Boilers, and on the means of preventing it, by Dr. Ritterbrandt. The first part of the paper shows that incrustation is the cause of the majority of Steam Boiler explosions. Secondly, that it is incompatible with the economical use of fuel. Thirdly, that it rapidly destroys the boilers, and that the extra heat necessary to raise water to a given point greatly increasing oxidation or scaling, and fourthly, that it is a source of serious expenditure, by rendering labour necessary to remove it, and by the destruction of the boiler, to which this mechanical removal gives rise. In order to obviate these difficulties, Dr. Ritterbrandt proposes to use the *salts of ammonia*, it being known that if to a soluble salt of lime be added a solution of carbonate of ammonia, precipitation takes place, and the acid which held in solution the lime, unites with the ammonia while the carbonic acid of the carbonate of ammonia combines and falls down with the lime, but upon the water being heated, the precipitated carbonate of lime combines with the salt of ammonia, is re-dissolved and the carbonate of ammonia is formed, and escapes with the vapour of the boiling water. On feeling convinced that this peculiar re-action took place, viz: that carbonate of lime precipitated from a salt of lime by carbonate of ammonia would be again dissolved by the application of heat, it only remained to be proved how far this principle was applicable to decompose the carbonate of lime already existing in calcareous water, and the results exceeded the most sanguine expectations; however, highly charged with lime the water may be, the process answers, and the solution is in all cases perfect.

The rationale of the chemical reaction was explained by the following diagram:



March 11.—T. Winkworth, Esq., in the Chair.

The first communication was by Mr. Waterhouse, "*On his Machine for the Manufacture of Mechlin Lace.*" It appears from the description of the machine and the specimens of the lace exhibited, to be one of great capabilities; the number of warp-threads in the width alone is 4,700, and a corresponding number of bobbins or weft-threads, which represent the same number of bobbins, and are all kept in motion at the same time. In making pillow lace, it requires as many hands as there are bobbins, for on the cushion one hand must wait for the other, in order to obtain the requisite crossings of the threads. Some idea may, therefore, be formed of the intricacy of the machinery, and of the ingenuity displayed in its arrangement, as by it every motion given to the threads by the hand is exactly given by the machinery, but with greater rapidity and precision. The process of the manufacture was described at length, and illustrated by diagrams and parts of the machinery itself; there were also specimens exhibited,—one of which was twenty-six yards long and four yards wide, and had four patterns woven upon it. The number of motions or throws that would be required to produce a similar piece of lace by hand would amount to not less than 2,111,616,000. The lace is said to be in no respect inferior to the foreign lace.

The next communication was, by Dr. Paltrineri, "*On a New Steam Engine, Magnetic Engine*, and other machines in which the moving power is applied simultaneously, by Action and Reaction, to the work to be performed, being illustrations of a system for obtaining all motive powers and maximum of effect." Dr. Paltrineri conceives that the maximum of effect is to be obtained by applying simultaneously the action and reaction of every motive power with equal velocities to the production of the useful effect. He exhibited a double turbine, in which the water, steam, or other moving fluid, is applied by means of two concentric wheels, through which the fluid passes successively, and by this means he showed that a residual effect, which is lost on the ordinary single wheel, would be converted to use by the double. He showed the same results in the case of his new magnetic engine, and he illustrated the fact by a machine in which the constant force of a spring is applied to raise a weight, first by having one bend released and the other fixed, and next by releasing both bends simultaneously, and in which latter case the maximum of effect is utilized. The machines were simple in their construction.

ON THE MANUFACTURE OF GLASS.

Abstract of a paper read at the Royal Institution. By Mr. Pellatt

Though we have accounts of foreign glass having been used in this country during the 7th century, yet the manufacture of glass in England is comparatively of recent date; the first manufactory having been established at Savoy House, in the Strand, in 1557, probably by French Protestant refugees, most of the technical terms in glass-making being from the French. In 1670, the second Duke of Buckingham advanced the manufacture by the introduction of Venitian workmen; and three years afterwards the first plate of glass was produced at the works of that nobleman at Lambeth. In 1773 a royal charter was granted to the governor and company of British Plate Glass Makers; their works are at Ravenshead, Lancashire, and are the most capacious in Europe. Since this period the manufacture of glass, notwithstanding the restrictions to which it has been subjected, but which are now removed, has continued to advance.

Crucibles and Furnaces.—Before considering the manufacture of glass, it is necessary to say a few words respecting the mode of preparing the crucibles and furnaces for melting the materials. Every glass-maker is his own potter and furnace-builder. The preparation of the crucibles involves the greatest care, because upon the quality of them depends all the after processes and results. The material used is fire-clay. The clay best suited is that which contains the most silica. The crucibles or pots are made by forming the clay into small rolls, which are spread, layer over layer, with considerable pressure: the whole is thus built up little by little, allowing the clay to harden so that the shape is preserved. During the building and afterwards, the pots are in a room in which the temperature is regulated at about 60°, and all drafts excluded; five or six months are required in this temperature to dry them. The reason of so much care is to exclude as much air from the clay as possible; which, if it existed in quantity, would, upon the pot being brought into contact with the high temperature of the glass furnace, become so expanded as to burst; and also to insure a capacity in the pot to withstand the sudden contraction and expansion to which it is exposed. Pots are of two different constructions—closed and open; the former are used only for *flint* glass, the latter for all other descriptions in both shapes. The upper part is the most capacious: the reason for this is, that the heat reverberates from the top of the crown of the furnace directly upon the top of the pots. The pots cannot, of course, be exposed *cold* to the heat of the furnace, but have to undergo a gradual heating till they attain a white heat, and this is done in a furnace constructed for the purpose, from which all air is carefully excluded; from this furnace they are removed upon iron carriages to the glass furnace. The heat required to melt glass, especially that made without lead, is very great; yet, on account of the danger to the crucibles from any sudden rush of air, it is impossible to make use of blast, or even fanners: the proper draft is secured by the construction of an air funnel, called a cave, and by having the glass-house so constructed that it can be closed from the entrance of external air above. Upon the arch of the cave the furnace floor or seige (from the French *siège*, seat of the pots) is constructed, formed of strong heavy square bricks. The round furnace is used for flint glass, the flames finding vent by flues passing through the pillars of the furnace, having chimneys upon the outside for carrying off the smoke. Square furnaces, again, are employed for glasses without lead, a greater heat being required; which is obtained by the grate-room running the whole length of the seige. The proper construction of the furnace is of great importance to the operations of the glass-maker; in fact, good glass cannot be made without a good furnace.

There are several distinct varieties of glass manufactured; and so different are they, both in preparation and manipulation, that they may be considered separate manufactures. There are, however, only two methods by which fluid or semi-fluid glass is formed to shape, viz. casting and blowing. Casting applies *exclusively* to *plate* glass, and is the emptying glass out of the pot by casting it out upon a table, the casting of glass as metal is cast, being yet unpractised; *blowing* applies to *all* other descriptions of glass.

The tools used by the glass-maker are simple: the blowing-iron—simply a hollow tube; with this the semi-liquid glass is gathered from the pot and blown out into shape; the punty, for attaching to the bottom of glass after blowing, so that the blowing-iron may be detached, and the glass, being heated up, may be cut with scissars, and afterwards formed. The shears or procellos, for shaping the glass whilst it is turned by the workman upon the arms of his chair, or working bench. These, with the addition of a pair of scissars and pincers, are the whole of the tools.

All glass requires *annealing* or *cooling;* the process is performed in a furnace called a lier, from the French *lier*,—figurative, perhaps, of the change in state, as well as atomic arrangement, which takes place during the cooling. We know that a change *does* take place, from the fact that glass before cooling is of greater bulk and less specific gravity than when cold; that it parts with a portion of *colour* during the process, probably by giving off oxygen; and that though, whilst in a fluid state, glass is a good conductor of electricity, when cold it is a non-conductor. The object of annealing is, by a gradual diminution of the temperature, to allow of that arrangement of particles necessary to the body at a low temperature, and which particular arrangement alone enables the glass to support sudden changes.

The base of all glass is silica: the most convenient form in which it is found is in fine sand; upon the due proportion of this substance in glass depends its compactness of body, brilliance and capacity to withstand sudden changes. It often happens, either on account of want of sufficient heat in the furnace, or in order to save time in the melting or founding, that too small a proportion of silica is employed. Glass which has this fault may be known by its rapidly attracting moisture. The different descriptions of glass made are known by the names of plate glass, German sheet or British plate, crown or window glass, bottle glass, and flint glass; there are others, but they are merely modifications of these, and need not be noticed.

Plate Glass is composed of sand, carbonate of soda and chalk, with small quantities of arsenic and manganese; the proportions vary at different works, but the general proportion is —Lynn sand, 400; carbonate of soda, 250; ground chalk, 35, by weight. The quality of the glass depends upon the quality of the alkali. Plate glass is melted in large open pots. The furnaces are square, containing sometimes 4, sometimes 6 pots each; when the glass is melted, which takes 22 hours, it is removed to another furnace, where the pots are smaller, of a cylindrical form. Here it is fined, which occupies 4 to 6 hours, and when free from air bubbles and impurity the pot with the glass is removed bodily from the furnace by means of a crane, and hoisted to the end of the casting table, upon which the glass is emptied; a large iron roller which works inside the flanges of the casting table, is then made to pass over the melted glass, in order to flatten it out; it is then removed upon a wooden table on wheels to the annealing arch, which is now at a high temperature, and here it is excluded from the atmosphere until cold. The glass is rough and uneven, but is afterwards cut flat by machinery, and then smoothed and polished; it is these processes which render plate glass so costly.

Crown, or window glass is of much the same composition as plate glass, except that a cheaper description of alkali is used; the ordinary mixture is, 500 cwt. Lynn sand, 2 of ground chalk, and 1 cwt. each of sulphate and carbonate of soda. The square furnace and the open pots are used, there being generally 6 pots on each furnace. It takes from 14 to 20 hours to melt this glass, and it then requires to stand 4 to 8 hours to allow it to become free from all air bubbles, and to cool sufficiently for working. Window glass is formed by blowing: upon the blowing-iron is gathered at three several times (the fluidity of the glass never allowing fewer) the weight of glass necessary to produce the table, and which weighs 11 lb.; this is then blown out, leaving a solid lump at the farthest extremity from the blowing-iron, for attaching the punty; this is called the bullion. The punty being fixed to the bullion, the blowing-iron is relieved by merely touching the glass with a wet iron; being firmly attached to the punty, it is removed to a small cylindrical furnace, called a flashing furnace, where a rotatory motion being given to it, increasing as the glass becomes softened by the heat, the centrifugal force, together with a little sleight of hand on the part of the workman, produces a flat circular plate or table, as it is then called.

British plate, or German sheet-glass is of the same composition as plate glass, but the manipulation is different. The glass is blown into open cylinders, and, when cold, these are cut open along the length with a diamond, and placed in a flatting furnace, which is at a sufficient heat to bring the glass into a semi-fluid state, so that it falls quite flat. The sheets thus made are afterwards cut flat and polished. The size of the sheet is restricted to what can be blown and worked by one man; it is cheaper than plate glass, because all waste is avoided, and less cutting is required.

Bottle glass is composed of the cheapest materials which can be procured—ordinary pit sand, refuse alkaline waste from soap works, refuse lime from gas works, &c. The proportions of the materials vary according to quality. Bottles are blown in moulds: the glass having been blown in the mould, nothing remains but to form the mouth; this is done, the bottom being attached to an iron punty, by holding the extreme edge of the neck to the heat for a short period, and, having collected a small quantity of liquid glass upon the end of a small iron, called a ring iron, a ring of glass is allowed to cover this extreme end, and this is afterwards worked into shape by a machine which forms the inside and outside of the mouth at the same time, merely by the workman turning the bottle on the iron upon his knee once or twice. The rapidity with which bottles are made is almost incredible; a workman, with the assistance of a gatherer and blower, will begin and finish 120 dozen of quart bottles in 10 hours, which averages nearly 2¼ per minute, and this is ordinarily done; and in some works the men are restricted to 2 per minute, to prevent the work being slighted. It may not be uninteresting to observe the low price at which this description of glass can be procured, now that the duty has been removed: quart bottles can be produced at the works at about 14s. per gross: each gross weighs 2 cwt., which is equal to 7s. per cwt., or £7 per ton, for manufactured bottles; if from this we deduct for workmen and incidental expenses, £2 per ton, it would leave the price of bottle glass £5 per ton.

Flint glass is thus designated from calcined flints having been formerly used in its composition; this is now replaced by fine sand. The term flint glass is now applied to all glass into the mixture of which lead enters, and is used in the manufacture of table glass, &c. In the manufacture of flint glass the circular furnace is used, the pots surrounding the grate room; on either side of the pots are flue-holes, which pass through the pillars, the smoke being carried up by flues outside these. The heat thus reverberates from the crown of the furnace, and is drawn round the pots previous to passing through the flue-hole. The melting pots are covered in, to protect the glass from dust, which would affect the colour. The materials used in flint glass are sand, red lead and litharge, carbonate and nitrate of potash, arsenic, and manganese; and the greatest care is taken in the selection of them—the beauty of the glass depending mainly upon the quality of the materials. The best sand comes from Alum Bay, Isle of Wight; this is carefully washed and dried previous to using. Red lead, or litharge: this assists as a flux, and gives density, brilliancy, and ductility,—the latter quality being particularly required in flint glass; it is, perhaps, owing to the superior quality of the oxides of lead prepared in England that we are in advance of other nations in the manufacture of fine flint glass. The carbonate and nitrate of potash are used wholly as fluxes; soda, though more active, is never used where quality is required, as it affects the colour. For almost every purpose, the best glass of every description is that which contains the greatest amount of silica. If the sand, lead, and alkali, even though the quality were never so pure, were melted, the glass which would be produced would not be colourless, but of a pale green; and this, in all probability, is not so much the result of impurity, as the deoxidating effect of the fusion. To obviate this, it is necessary to use oxide of manganese, which, by supplying oxygen, retains the different substances in that state of oxygenation necessary to a colourless glass; if too much manganese be used the colour is slightly purple, designated by the glassmakers "high; the green tint, again, is called "low:" in other words, the glass is high when it contains more than sufficient oxygen, and low when too little. Minute quantities only are necessary; from a quarter to half an ounce per cwt. is sufficient. Arsenious acid is sometimes used in flint glass, its use being to expel the carbonic acid gas present in the materials; if too much is used it gives opacity.

Glass must be considered, unfortunately for science, an imperfect body. The principal imperfection, more especially of flint glass, arises from what are called cords, or striæ in the body of the glass, which give it the appearance of alcohol and water imperfectly mixed; through these striæ the rays of light will not pass, but are diverged and broken. This defect is attributed to the difference in specific gravity, or want of homogeneity of the particles: this, no doubt, is true; but the question is, to what cause is this attributable? I would suggest, that it may arise from the unequal distribution of heat to the materials during fusion and whilst in a fused state, and to the particular action consequent thereupon. The number and variety of articles manufactured in flint glass are great, and require considerable practical experience on the part of the workmen. It is impossible to describe the manner of operating, which appears even to those who have often seen it almost magical. It is certainly surprising to see an apparently opaque and fluid body in a moment become transparent and solid, and, whilst undergoing this rapid change, to see it take beauty of form.

Coloured Glass.—The substances used for producing coloured glass are the metallic oxides, the quantity being proportioned to the depth of colour we desire to obtain. For *blue* glass we use oxide of cobalt; this produces a rich colour: the material, however, being expensive, it is seldom used by the glassmaker alone, but generally with an equal quantity of manganese; this materially affects the richness of the colour. *Green* is obtained from the oxides of copper and iron, mixed, the protoxide of copper and the peroxide of iron: equal quantities may be used, the proportions being varied according to the tint desired to be obtained: the copper produces a blue-tinted green, and the iron the *yellow* tint. *Purple* is obtained from the oxide of manganese; the purer this substance is, the finer will be the colour. The pyrolucite already referred to, especially when used in small quantities, gives a beautiful and delicate amethyst colour. Ordinary yellow is got from carburate of iron and oxide of manganese. *Ruby* is obtained from the oxide of gold, called the cassius precipitate; it is a colour which is neither obtained nor retained with any certainty—in fact, the modern glassmaker is quite at a loss for this colour. There can be no doubt the ancients manufactured ruby of a much finer colour than any now made, from suboxide of copper; this art has been lost for centuries: the difficulty is, the preventing this substance from peroxidising. The oxides of uranium produce beautiful tints in yellow and green. Copper scales give *azure blue*; oxide of chromium, *emerald green*. Opaque glass is produced by the addition of phosphate of lime, arsenic, and other substances. The addition of many of the metallic oxides renders glass less ductile; and in making use of these it is always well to employ an additional quantity of lead. We often hear of the superiority of the colour of ancient sheet glass to the modern, and are bound to conclude, when we see, particularly in church windows, the difference, that there is good ground for the assertion. With the exception of ruby, the modern colours are all finer than the antique. I speak of body colours—that is, glass made of coloured mixtures, called pot metal; but this is seldom used, all our modern church windows being made of white glass stained with metallic colours; this saves trouble and expense in the fitting. Glass of various colours in the same piece is obtained by casing one metal or glass with another. A small quantity of one colour having been gathered, it is blown into a small ball, and dipped into a pot of a different colour; this being rolled on an iron slab, so that an equal thickness of the second covers the first, the ball is a trifle enlarged by blowing, and may be dipped into a third and fourth colour. Care must be taken that the character of these different glasses exactly agree, that the contraction in cooling may be alike.

RAILWAY PROCEEDINGS.

Selections from the decisions of the Sub-Committees on Standing Orders. House of Commons—Session 1846.

Gazette Notices.—In the Committee on the Runcorn and Prestonbrook Railway, it was stated by the solicitor for the bill that the notices had only been twice published in the *Gazette*. He had delivered the notices at the *Gazette* office on October 23, with instructions for three insertions. Mr. Watts, the editor of the *Gazette*, said he found by an entry in his book that the notice had been withdrawn. Has no means of knowing by whom it was withdrawn. Mr. Turner said he had given no instructions for the withdrawal of the notice. Mr. Watts said it might have been a mistake, arising from the pressure of business at that time. The committee decided that in this instance the standing orders were not complied with.

Public Roads.—In the Committee on the Wexford, Carlow, and Dublin Junction Railway, an allegation was made that a public presented county road, in the townland of Killurin, was described to be in the ownership of the Earl of Arran, whereas in fact it was a public road under the jurisdiction of the grand jury and road surveyor of the county of Wexford. The allegation turned on the ownership of these roads, whether in fact the right owners had been entered in the book of reference. The chairman observed, what is intended is, that the fee in the land is in certain other parties, but the public have a right of road. That comes to the state of English roads. There the property is not in the surveyors or trustees. A mine under the road does not belong to the trustees. The practice in England is to treat the ownership of the surface as that which entitles the parties to be served. The question is, whether there is anything which entitled you to take the Irish roads out of this condition. We cannot draw any distinction between the cases. If so, you ought to give notice to the persons in Ireland, who answer the same description there, as the surveyors of roads in England. As regards these allegations, we shall report that the standing orders have not been complied with, inasmuch as the grand jury of the county of Wexford have not been inserted in the book of reference as owners of certain roads particularly specified.

Ownership of Lands.—In the Committee (No. 2) on the Glasgow and Ayr Railway, the petitioner opposing the bill alleged that in several instances the promoters had inserted, in their book of reference, the name of the reputed and substantial owner of the land, in cases where there was a superior owner or feu lord, to whom a merely nominal payment, in respect of the land, was annually made. It was submitted that the book of reference ought to have contained the names of such feu lords. The chairman remarked on that point, that the committee had always considered the reputed owner, in such cases, as sufficiently the owner for the purposes of the book of reference, and not the superior lord, who, in most cases, had only a peppercorn rent reserved to him.

Notices.—In the Committee (No. 3) on the Midland and Bradford Railway, the petitioner opposing alleged that the *Gazette* notices had been given for six lines of railway, and the bill was only for one. In the cases decided last sessions, the Direct Northern, the Wells and Dereham, and Goole and Doncaster Railways, where they came to Parliament for a shorter line than they had given notice of applying for, were held as not having complied with the standing orders. The promoters contended that the cases quoted were not analogous to the present. The notices given announced the intention of the promoters to apply for powers to construct six railways, and this might be called the first of the series. In the case of the Direct Northern, who gave notice of making a railway from London to York, and afterwards only came for powers to make a line from Cambridge to York, a landowner on the line between Cambridge and York might be willing to concur in the whole line, but might object to have his land cut up by the shorter line. The committee were of opinion that there had been a sufficient compliance with the standing orders in this case upon that point.

Withdrawal of Petition.—In the Committee on the Grand Union Railway an opposition was about to be entered into by Mr. Thomas, when Mr. Burke objected, as the petitioner had withdrawn his consent after the presentation of the petition. It was contended on the other side that it was not competent to any person to withdraw a consent once given. The chairman after conferring with the chairman of another committee stated, that the committee had given their best consideration to this case, and they regretted that the standing order No. 9 was not more clearly worded. If they abided strictly by its words they would not decide according to the intention of the house, as there would be constantly raised questions as to the manner in which consents had been obtained. Their decision therefore was, that it should be in future in the power of any petitioner to withdraw his consent to the petition. The petition was then withdrawn.

Levelling Books.—The Committee (No. 2,) sitting on the Edinburgh and Glasgow and Dumbartonshire Junction Railway, in a case of dispute as to the correctness of the levels, decided that the promoters of the Bill should produce the notes of the levels.

Parish Boundaries.—In the same Committee, and on the same Bill, a petition alleged that in the plans deposited with the sheriff clerks of Dumbartonshire and Lanark, the parish boundaries of the parish of Dumbarton were not written in words, whereas the boundaries had been so written in the plans lodged at the Private Bill-office. This allegation was sustained, as was also the second, which had reference to a discrepancy in the plans lodged with the sheriff-clerk of Dumbartonshire, and that deposited at the Private Bill-office, in regard to another omission in the county plans of the words "parish boundary."

Cross Sections of Roads.—In the Committee (No. 7) on the Cornwall Railway, the opponents to the bill objected that the 42nd of the standing orders had not been complied with in respect of a proposed alteration of a turnpike road not having been shown in figures nor on the cross sections.—Mr. Brunel stated that any surveyor or engineer would understand the section. The Chairman, having inquired whether there was any case reported, in which, after argument, it had been held that the standing orders had been complied with, although such alteration or inclination had not been set down in figures, ordered the room to be cleared, and upon the doors being re-opened, stated, that the Committee were of opinion that the standing orders had not been complied with in respect of any of these cross sections.

Petitioners.—The Committee (No. 4) on the Dublin and Enniskillen Railway decided that it was absolutely necessary, in order to comply with the standing order No. 9, that the petitioner, authorising an agent to appear for him, should be proved to have been cognizant of the actual allegations contained in the petition. In the absence of this proof the petition could not be entertained.

Withdrawal of a Portion of a Line after Notice.—In the Committee (No. 2) on the Northumberland and Lancashire Railway, two important allegations were made against the bill; the effect of the *first* was substantially this—that whereas the promoters of the bill gave notice in the newspapers, and to the petitioner, amongst others, of their intention to make a railway, commencing at a point called A, and terminating at a point called C, with divers branches therefrom; but their petition only asked for the authority of the House to bring in a bill for executing a portion of that work only, and that a very small portion. The promoters had, in fact, greatly modified their original project, and had abandoned a considerable portion of it, but had not given fresh notices to the landowners on the line or in the newspapers of such modification and abandonment. After the question had been argued at some length, the Chairman announced that the standing orders had been complied with. The second allegation was that a sum equal to one-tenth part of the amount subscribed in the subscription contract deed had not been deposited with the Court of

Chancery, inasmuch as the sum actually subscribed was the sum of £1,285,840, which would require a deposit of the sum of £128,584, whereas the amount which the promotors had deposited was only £93,066. The question depended upon the construction of the standing orders 39 A and 29 A. The point appeared of some importance, and the Chairman retired, with the view of consulting the Speaker upon it. After hearing the arguments of the agents on each side, the Chairman (Sir John Y. Buller, Bart.), on his return, said the Speaker quite agreed with him that the intention of Parliament was quite clear on the point, and that three-fourths of the amount of the estimate was all that was required by standing order 29 A to be subscribed, and that one-tenth part of the amount subscribed should be deposited with the Court of Chancery by the order 39 A. In this case the sum actually subscribed was £1,285,348, but, in consequence of the promoters abandoning a considerable portion of the works, the sum required for the undertaking was reduced to £758,000, and they had deposited £93,066, a sum larger than they would be called upon to deposit in respect to £758,000, the estimated cost of the work, even if the construction of the standing orders required, as was contended by the petitioners' agent, one-tenth of the sum subscribed to be deposited. He (the Speaker) thought the House had no right to find fault with and punish parties for doing more than the requisitions of the House demanded. The Committee, therefore, thought that, on this point, the standing orders had been complied with.

NOTES OF THE MONTH.

We are sure that many of our readers who were acquainted with the late Mr. Loudon, will feel gratified to hear that a pension for life of £100 per annum, has been granted by her Majesty to Mrs. Loudon. Sir Robert Peel has just communicated to Mrs. Loudon this act of beneficence. To her it will be doubly grateful, as it is conferred in consideration of her deceased husband's labours and writings on subjects of science.

At the Marquis of Northampton's second soirée there was exhibited a cast of "Charity," moulded out of pounded marble combined by a cement, so as to imitate the original marble.

The Archæological Institute, under the presidency of Earl Fitzwilliam, will hold their next annual meeting at York, on Tuesday, 21st of July next.

It is proposed to construct a glass saloon at the Botanic Gardens, Manchester, of sufficient size to receive the usual exhibition of flowers, plants, and fruit, and all the promenades, and to be also available for lectures. It is to be 150 feet by 45 feet; and 22 feet in height to the centre of the dome, or 32 feet to the centre of the dome ventilator. The whole of the front is to be made of glass, and moveable, so that it may be removed in fine weather. The west end of the building is to have a semicircular alcove or recess, for the reception of the band. The area of the building will be equal to 6,750 square feet, and will accommodate nearly 2,000 persons. The whole space of the interior is to be made available; no pillars or other obstructions are to be introduced; but the ribs of the frame-work are to be tied beneath the floor. Messrs. Irwin and Chester, architects, of Manchester, have been entrusted with the designs by the Council, for approval.

A very interesting experimental trial of Nasmyth's steam hammer of 50 cwt., lately took place at the Chatham dockyard, where it has been recently erected. The trial commenced with breaking up old and condemned anchors, under the superintendence of the patentee and Captain W. H. Sherriff, superintendent of the yard. Anchors of various sizes were broken up in lengths with perfect ease—in some instances by one fall of the hammer; after which, a part of the shank of an anchor, of about 30 cwt., was heated to a welding heat, and beaten out by the hammer to a rod of about four inches in diameter. Here proof was given of the perfect control under which the inventor had the hammer in finishing off or rounding up. It was brought out from under the hammer quite equal in finish as it would have been by the small forge hammer. In beating out iron for conversion, the blows are so powerful and effective that it drives out all spurious materials from the iron, and perfectly consolidates the whole mass; in proof of which, the four-inch rod was cut into various lengths and exhibited a beautiful specimen of solid metal, whilst the part of the shank, that had not been under the hammer, showed nearly every bar and rod with which it had been made, except within about an inch of the outer surface. Mr. Nasmyth has orders to provide a patent steam hammer for each of her Majesty's dockyards.

The *Roman Amphitheatre at Dorchester* which by the timely interposition of the British Archæological Association has been preserved from destruction, is one of the most interesting of our national antiquities. The area is about 218 feet by 163 feet; it is of an oval form, and is surrounded by a mound of considerable thickness, formed of blocks of chalk cut from the centre, which is consequently much lower than the external surface. This wall is about 20 feet high. The amphitheatre at Silchester is of nearly the same form and dimensions as that at Dorchester, but it is not in such a perfect state of preservation. The area of the Coliseum at Rome is a trifle larger, being 263 feet by 165 feet. Mr. I. K. Brunel, the engineer of the Weymouth Railway, which was planned to cut through the amphitheatre, very readily and courteously admitted the plea of the association for the preservation of this ancient monument, and took proper measures to divert the line.

Architectural metamorphose has just transformed the originally dowdy and most mean-looking exterior of Bedford Chapel, Bloomsbury Street, into not merely a sightly, but a rather striking object, one moreover that displays considerable novelty of design,—in which some good as well as fresh ideas are thrown out. At the same time it is to be regretted that it betrays great inequality of taste. While there has evidently been a good deal of petty parsimony in some respects, money has been not only uselessly, but rather mischievously expended on what are intended for ornaments, but in reality eyesores,—we mean the trumpery obelisks stuck up at the angles of the building, and producing at a little distance the effect of pinnacles, consequently quite inconsistent with the style. On the other hand, something certainly ought to have been done to what was left of the old gable and the belfry lantern upon it, for the latter is not at all in keeping with the new exterior, and the other shows most awkwardly as a mere triangular bit of wall, seen poking up behind the front, but not at all belonging to or connected with it. Another very great blemish marring the front— which would else possess considerable merit—is occasioned by the two smaller doors next to the middle one, being out of the centre in regard to the intercolumns or arcades, in which they come. This very disagreeable irregularity might easily enough be remedied even now, by merely hanging additional outer doors before the two mentioned, so as to be flush with the wall, and painted or coated over so as to be of the same colour, in other words those should be what are called *jib* doors,—as is the case with the additional carriage entrance in the front of Northumberland House.

Sir Robert Peel has announced to the House of Commons her Majesty's intention of appointing a Royal Commission for considering the various projects for railway termini in the Metropolis.

In consequence of the valuable collection at the Museum of *Economic Geology* having increased so rapidly, it has been found necessary to build a larger museum, for which purpose a large plot of ground has been cleared of its buildings in Piccadilly, near St. James's Church.

It is proposed on the projected railway from Lyons to Vaise, to have a tunnel on that part of the line under *Croix Rousse*, with shafts to communicate with the commune above, through which the passengers are to be raised and lowered, seated in elegant boxes or apartments.

Travelling by Steam on the river Thames between London and Westminster Bridges is reduced to the low fare of one penny for each passenger.

The Metropolitan Improvements of New Oxford Street are fast approaching completion, and it is expected that the roadway will shortly be thrown open for the passage of vehicles; the whole of the buildings having an architectural frontage, presents a pleasing appearance.

It is stated that the laying down of wooden pavement and subsequent removal for the old granite, cost the city of London £40,000 last year.

The new street from Farringdon-street to Clerkenwell is to be called Victoria Street.

The site for a new church has been selected by the Metropolitan Church Commissioners in Old-street, City-road, the first stone of which will be almost immediately laid.

The repairs and restoration of Chester Cathedral are nearly completed, with the exception of the pulpit, for which orders have just been given, it is to be constructed of Painswick stone, from a design by Mr. Hussey, of Birmingham, under whose superintendence the restorations in the choir have been effected.

The Terrible War Steamer.—The Terrible war steamer is in commission, and lately made a trial of her speed down the Thames from Woolwich to below the Nore; she has twenty guns mounted, also a brass field-piece and carriage, and a wagon for powder to accompany it. On her upper deck, each side the bow, are two long 56-pounders, Monk's 11 feet guns, to fire fore and aft in a line with the keel; these are mounted on a slide, and will cross fire with each other, and also sweep round to the sides; two more of the same guns, right aft in the stern, will also cross and sweep to the broadside on their pivot, so as to fire forward, acting as chase guns if required. She has two 68-pounders on each broadside, to carry shells or solid shot, which can be trained fore or abaft, according to circumstances. On the deck below, which is also flush fore and aft, are eight guns, viz., two long 56-pounders, Monk's guns, 11 feet long, in the bow ports, to fire in a line with the keel, and also several degrees of training on the broadsides, and two of the same guns in the stern, right aft, which can give such depression as to prevent even a small boat from coming under her stern; with four guns, 68-pounders, on her broadsides, for shells or solid shot. There are four smaller guns on the upper deck, to be traversed to any place or carried on shore in her paddle-box boats, if required for use in landing troops, &c. She has four separate boilers, independent of each other, which may be connected when required; four funnels, one to each boiler; the two after ones strike down, so as to allow a square mainsail to be set when sailing, and still using the two foremost boilers, thus working half her power, at the same time saving a considerable consumption of coals. This is an excellent contrivance, as there are four small funnels, instead of one large one, which is a great advantage, as the ship will not be wholly disabled by losing one, two, or even three funnels, like the one funnel ship would be on hers being carried away; her one funnel lost, she has lost all. The Terrible has two magazines, and two shell-rooms, one of each before the engine-room, and one abaft for the safety of the vessel, to prevent any powder passing the engine room when firing the guns. She can store 400 tons of coals below the lower deck, and is prepared on the midship part of the deck to take 200 or 300 tons more, packed in bags, as a defence from shot to the engines and boilers, filling up a space of 18 feet. In addition to her thick, substantial, solid sides, she has good capacity, and if required for any particular service can carry more coal in sacks. With regard to the conveyance of troops, she can berth 1,000 men under cover on her second gun-deck, independent of her ship's company, their berth being below forward, and the officers' cabins, gun-room, &c. abaft; so that each gun-deck is entirely clear and always ready for action, without removing a bulkhead, and the deck being perfectly free from the captain's cabin abaft, to the bow of the vessel. She is constructed in the strongest and most substantial manner, on Mr. Lang's improved method of uniting the frame timbers, making her perfectly water-tight, so that she would swim even if her external keel and plank were off her bottom. This method is also adopted in the Royal Albert, 120 guns, now in her frame, and may be seen on the slip in Woolwich dockyard. The engine-room of the Terrible is most splendid;

on deck, the whole length of the engine-room, are gratings open and well ventilated by hatchways, giving light and air to the engineers, stokers, &c. It is an admirable plan, such as no steamer as yet has the advantage of; and each boiler has a separate hatchway, and may be readily taken out for repair, without interfering with the other boilers. This method of Mr. Lang's invention prevents the necessity of ripping up the deck, which is the case with other steamers when the boilers are required to be taken out from those vessels, and there too, the deck covering the boilers, the engineers and stokers have the light admitted by the hatchway over the engines only. The Terrible's engines are most majestic; they are 800-horse power, the production of Maudslay, Sons, and Field, and show to advantage in this large war steamer. Her decks have hatchways in various parts, scuttles, sky lights, &c., for ventilating the ship even to the lower parts of her hull; and there are many other conveniences too numerous to mention, contributing to the efficiency of the ship and the comforts of the officers and crew, so that she may be said to be the largest and most perfect war steamer ever built. The Terrible is commanded by Captain Ramsay, late of the Dee steam-vessel, and she is to have a complement of 240, officers, men and boys. At the trial, when she was off Sheerness, her rate of speed, by Massey's log, was 10·8 knots per hour; the engines making 14 to 14½ strokes per minute.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM FEBRUARY 25, 1846, TO MARCH 25, 1846

Six Months allowed for Enrolment, unless otherwise expressed.

John Samuel Templeton, of Sussex-place, Kensington, artist, for "improvements in propelling carriages on railways; and improvements in propelling vessels."—Sealed February 27.

Peter Armand Lecomte de Fontainmoreau, of New Broad-street, London, for "a new mode of manufacturing and glazing cotton wadding, and its application to the making of mattresses." (A comunication.)—February 28.

James Soutter, of Limehouse, engineer, for "an improved pump, applicable to steam-engines, or other purposes."—March 2.

John Fuller, of Beacham-well, Norfolk, farmer, for "improvements in apparatus for sowing corn or other seed."—March 5.

William Nicholson, of Manchester, Lancaster, engineer, and George Wardsworth, of Sutton glass-works, in the same county, manager, "certain improvements in the manufacture of glass and other vitreous products."—March 5.

Robert Lewis Jones, of Chester, railway agent, for "improvements in reducing charcoal and other similar matters, to powder, and in treating the same when in a state of powder, so as to render them suitable to be used in place of vegetable black-drop, black, lamp-black, and other matters."—March 5.

Robert Warrington, of Apothecaries'-hall, London, chemist, for "improvements in preserving animal and vegetable substances."—March 5.

William Green, of Hyde, Cheshire, baker, and Mark Walker, of the same place, grocer, for "certain improved apparatus for facilitating the putting on of boots to the feet."—March 11.

Godfrey Woone, of Kensington, Middlesex, gent., for "certain improvements in the art of engraving in relief."—March 11.

Jean Joseph Ernest Barruel, of No. 172, Rue St. Jacques, Paris, chemist, for "improvements in working of certain sulphurets to transform them into metal or oxides, and to collect the latter; also to collect the oxides from oxydised ores, equivalent to these sulphurets."—March 11.

William Nairne, of Millhaugh, Perth, North Britain, flax-spinner, for "a new mode, or new modes, of propelling carriages along railways.—March 11.

Parfait Grout, of Rouen, France, but now residing at Leicester-street, Leicester-square, doctor of medicine, for "improvements in the manufacture of plaster-of-paris, lamp-black, and coke." (A communication.)—March 11.

Frederick Crace Calvert, of Paris, for "improvements in the preparation of the article called 'Jute,' rendering the same suitable for various useful purposes."—March 11.

William Price Struve, Swansea, civil engineer, for "improvements in ventilating mines."—March 11.

Erasmus B. Bigelow, Boston, Massachusetts, for "certain new and useful improvements in looms for weaving certain kinds of carpets, or other fabrics of like character." —March 11.

George Hinton Bovill, of Millwall, and Robert Griffith, Havre, France, engineers, for "improvements in apparatus applicable to the working of atmospheric and other railways, canals, and mines, and in improvements in transmitting gas for the purpose of lighting railways and other places."—March 11.

Benjamin Shaw, Bradford, York, overlooker, for "improvements in preparing for spinning worsted and other yarns."—March 11.

Thomas Vaux, Frederick-street, Gray's inn-road, Middlesex, land-surveyor, for "improvements in the manufacture of horse-shoes, and horse-shoe nails."—March 11.

Charles Robert Robinson, Strines, Derby, calico-printer, and William Bowden, of the same place, mechanic, for certain improvements in machinery for washing and cleansing cotton, linen, or woollen fabrics."—March 11.

John Benfield, Birmingham, Warwick, organ-builder, for "certain improvements in making signals and communications on railways, and between railway-engines, carriages, and trains, which are also applicable to other localities."—March 11.

Henry Austin. 10, Walbrook, London, civil engineer, and Joseph Quick, Summer-street, Southwark, Surrey, engineer, for "improvements in the construction of railways, railway-carriages, and conveyances."—March 11.

Thomas Hancock, Stoke Newington, Middlesex, esquire, for "improvements in the manufacturing and treating of articles made of caoutchouc, either alone, or in combination with other substances, and in the means used or employed in their manufacture."—March 18.

John Longbottom, of Edward-street, Leeds, mechanist, for "improvements in the manufacture of oil-cake, and in the machinery and processes for pressing and moulding the same: which machinery and processes are also applicable to the manufacturing of other articles from plastic materials."—March 18.

Bennett Woodcroft, of Manchester, printer, an extension of letters patent for the term of six years from the 22nd day of March, 1846, being the expiration of the first term of fourteen years for his invention of "certain improvements in the construction and adaptation of a revolving spiral paddle for propelling boats and other vessels on water."—March 21:

John Haskins Gandell and John Brunton, of Birkenhead, Cheshire, civil engineers, for "an improvement in the construction of, and in the mode of opening and closing of moveable bridges or arches for the purpose of carrying railways, tramways, or other roads across canals, locks, docks, or other open cuttings."—March 25; two months.

Charles Robert Robinson, of Strines, Derby, calico printer, for "certain improvements in machinery for tiering, in the printing of calicoes and other fabrics."—March 25.

Charles Iles, of Bordesley, Birmingham, machinist, for "an improvement in the method of carding certain descriptions of dress fastenings, and other articles, and in the fabrics employed for that purpose."—March 25.

Thomas Howard, of the King and Queen Iron Works, Rotherhithe, engineer, for "improvements in steam-engine condensers."—March 25.

Robert Warrington, of South Lambeth, Surrey, gentleman, for "improvements in the operation of tanning."—March 25.

Thomas John M'Sweeny, of Killarney, gentleman, for "improvements in steering ships and other vessels."—March 25.

George Fergusson Wilson, of Belmont, Vauxhall, George Gwynne, of Chester Terrace, Regent's Park, James Pillans Wilson, of Belmont, aforesaid, and John Jackson, of South Ville, Wandsworth, gentlemen, for "improvements in producing light, and in materials and apparatus applicable thereto; and in treating fatty and oily matters."—March 25.

Alexander Parkes, of Birmingham, artist, for "improvements in the preparation of certain vegetable and animal substances, and in certain combinations of the same substances alone, or with other matters."—March 25.

Thomas Pope of Kidbrooke, Kent, gentleman, for "improvements in apparatus for moving railway carriages on to railways, and in machinery for lifting and moving heavy bodies." (A communication.)—March 25.

Louis Serbat, of Saint Soulve, in the department of the Nord, in France, chemist, for "a new method of constructing the roofs of houses, buildings, sheds, and all other erections."—March 25.

William Unsworth, of Derby, silk manufacturer, for "certain improvements in looms for weaving."—March 25.

Charles Smith, of Newcastle-street, Strand, Middlesex, for "improvements in cooking and culinary utensils, and methods of heating and suspending, or fastening articles of domestic use, and similar purposes."—March 25.

Joseph Needham Tayler, of Chelsea, captain in the navy, for "certain improvements in propelling vessels; and also certain improvements in constructing vessels, so as to be used in combination with certain machinery or apparatus for moving sand-banks and other obstructions to navigation, part or parts of which machinery or apparatus may be used on railways, or may be adapted and applied to carriage or common roads."—March 25th.

Edward Crump Dell, of Highgate, Middlesex, surgeon, for "certain improvements in apparatus for lighting the magazines and other parts of ships; applicable also for the general purposes of lighting buildings, roads, or ways."—March 25.

Edwin Cotterill, of Birmingham, manufacturer, for "certain improvements in articles applied to windows, doors, and shutters, part of which has been communicated to him by a certain foreigner residing abroad."—March 25.

William Carpenter, of Bridge-street, Banbury, Oxford, watchmaker, for "certain improvements in threshing-machines."—March 25.

CORRESPONDENTS.

Messrs. Blair and Phillips have written to us denying that they have confounded the laws of motion and equilibrium in their tract, reviewed in this Journal last month, and entitled "An Essay on an Improved Method of Construction for Viaducts, Bridges, and Tunnels, being an Application of the Principle of Universal Gravitation, as illustrated in the Solar System." If they really have not made this mistake we cannot help saying that they have been particularly unfortunate in the choice of a title to their work. Their opinions have certainly the merit of novelty, but as they are not supported by any proof except those which may be supposed to be derived from an inspection of their diagrams, it seems no more than fair that they should point out where the standard writers on the theory of the arch—Moseley, Poncelet, Rondelet, &c.—have failed in their reasoning.

Christ Church, Plymouth.—In answer to our old contributor Candidus, (see page 68), we would observe that we assumed it to be an essential principle of Pointed Architecture that the north and south walls of a church should have windows, simply because we find this to have been universally the case, without one single exception, in the ancient examples of the art as practised by its inventors. It is also an indispensible principle of *all* good architecture that the light should be generally diffused, so that no part of a building may be rendered inconvenient or useless by its darkness. In a church lighted by clerestories only, the north and south aisles being deep recesses without windows, this defect must exist; and it will be only aggravated by bisecting the recesses by galleries—unless indeed the light be of that convenient nature that it can shine round a corner. The extent of unbroken surface of the north and south walls is also a great objection. It is a characteristic distinction between Christian and Greek architecture that large continuous surfaces without openings are contrary to the spirit of the former. The case of the lanthern of Ely Cathedral is a strong precedent—for our view of the question, for at Ely it is a matter, not of opinion, but fact, that the intersection of the nave and transepts is lighted not only by the lanthern but by the lower windows. The main principle for which we contended is that in Ecclesiastical architecture, the vertical lights are modified by the horizontal.

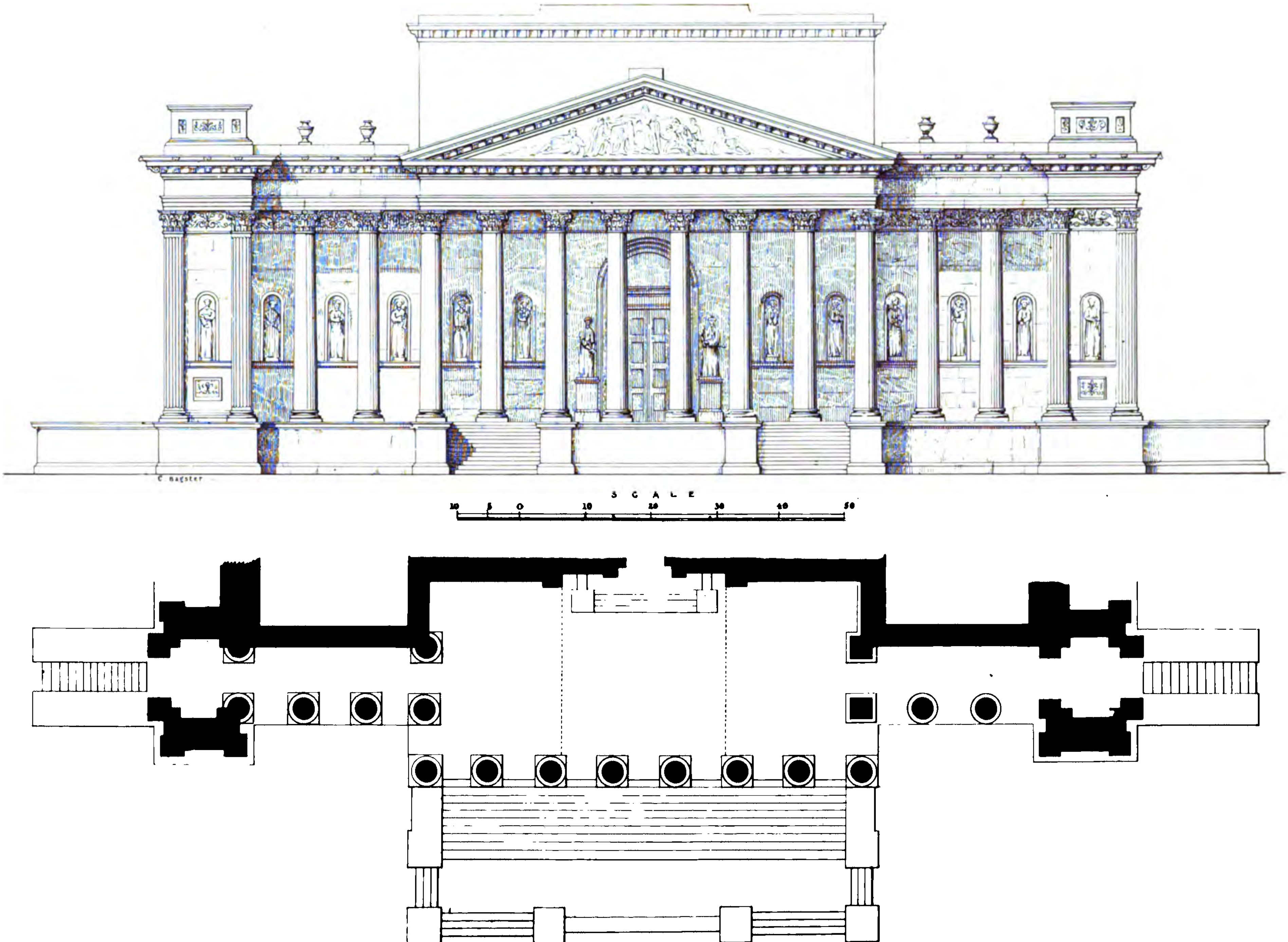
Amicus.—Simms on Levelling.

ERRATA.—Page 106. In the article on "Unfaithfulness in Architecture," in the concluding sentence of the last paragraph but one, after the words, "instead of supporting a building, it is supported by it," add "are instances of architectural unfaithfulness."

Page 108. "Parsey's Air Engine." In the last paragraph but three, for $\frac{100}{x}\,dx$, read $\frac{1000}{x}\,dx$.

Page 102. "Tubular Bridge over the Menai." In the last paragraph of the section on the "Practical limits to the length of the girder," for "independent of the arch of the cross sections," read "independent of the area of the cross sections."

FITZWILLIAM MVSEVM - CAMBRIDGE



GEO BASEVI - ARCHT -

THE FITZWILLIAM MUSEUM.

(*With an Engraving, Plate VI.*)

Possessing some points of resemblance, the façade of the Fitzwilliam and that of the British Museum are the antitheses of each other in regard to architectural composition and taste. The Cambridge edifice was infinitely more fortunate than the metropolitan one will have been; and perhaps very much better than it might have been had there been no competition—no trial of skill, but had the building-trustees merely placed themselves in the hands of some "crack name" in the profession. And whatever may be said against the little dirty jobbing that is so rife in the paltry hole-and-corner competitions in which ten or twenty guineas are offered for the *successful* design,—the Fitzwilliam Museum is a proof of the beneficialness of Competition when conducted with good faith, and with the sincere intention of obtaining a good design, no matter by whom it might be. At that time hardly would the name of George Basevi have been any recommendation, for he had given no great promise of particularly good taste in any of his previous works,—to own the truth, we ourselves should have felt more prejudiced against than prepossessed in favour of him. However, when the opportunity for accomplishing something of note did present itself, he responded to it worthily, and produced what is by far the most elegant structure in the classic or modern style that Cambridge can show,—beyond all comparison superior to the affected would-be Grecian style, and miserable pedantic dulness of Downing College. Had not the latter been so decided a failure, it is probable that its architect would have been engaged to make designs for the Museum, yet we question whether he would have produced anything so good by many degrees, for Wilkins was not at all gifted with imagination or invention: he had in him more of the archæologist than of the architect—that is, the artist;—he had too much of the mere rust of antiquity, and too little of the sterling metal of his art.

Pre-eminent among all the buildings at Cambridge with which it at all admits of comparison, the Fitzwilliam Museum, at least its façade—is hardly rivalled by any other of its time in this country, in point of novelty and felicity of idea, and for equally captivating and striking effect. Or if there be any other which has so much of *picture*, and of the poetry of the style in it, we shall be glad to learn where it is to be found, in order that we may honour it accordingly, and have something we yet wot not of, upon which we can bestow our cordial admiration.

Were it little remarkable in any other respect, the façade we are speaking of, most strikingly exemplifies the possibility of obtaining decided novelty of composition, and consequent originality of character, in perfect accordance with the style followed. The idea here adopted is so exceedingly *natural*, that our chief wonder is at its having been missed so long; and that it was, is to be accounted for only by that unlucky adherence to routine, which apparently prevents architects from seizing hold of fresh ideas, and new combinations. We do not say that all fresh ideas are to be laid hold of indiscriminately and actually adopted; all we mean is that those which can be made something of, and be satisfactorily matured, ought to be brought forward whenever opportunity offers. Nevertheless in regard to columnar composition architects seem to have voluntarily renounced all originality of design. Modern porticoes—and their name is "legion"—are almost one and all the most common-place affairs imaginable,—the work of the stone-mason rather than of the architect, consisting as they do only of so many columns in front—four, six, or eight, wrought after some prescribed standard example. Dulness seems to have set its mark upon almost every thing of the kind, for out of some hundreds of modern examples—or, we should say, instances—there are hardly half a score which exhibit aught of design, or even study. Indeed, the majority of them are no better than arrant "Brummagem,"—a few columns beneath a pediment tacked on to a front which in many cases would be a degree less intolerable, certainly less paltrily vulgar without them. Among the exceptions, the portico of the Fitzwilliam Museum deserves an honourable place: instead of being *after* some antique specimen, it has the better merit of being *before* almost all modern ones, in respect to beauty of arrangement, in which respect it can be but imperfectly appreciated from the elevation alone, much of the peculiar merit of the design arising from the plans, and not to be understood, except in the building itself, where it is plainly enough felt, without a drawing of the latter kind. The Fitzwilliam Museum has in consequence been taken in the article "Portico" in the Penny Cyclopædia, as an example of peculiar arrangement, and we might fairly call it one that at present constitutes a class by itself, or else the model for a class that would afford scope for design. Confined as they now are to mere columniation in its simplest mode, porticoes are made features stamped by most monotonous and wearisome sameness; yet after all that can be done, there must ever be enough of characteristic resemblance and conformity to the original type, the *frontispiece* or external elevation of the prostyle or portico division, invariably consisting of a line of columns beneath a pediment. In that respect there is but one stereotype idea to work upon, and all the variety that can be imparted to it amounts to no more than minor differences as regards matters of detail and execution. Still it is this mere stereotype frontispiece that chiefly obtains notice, and if that be but *secundum artem*, and upon a tolerably imposing scale, the whole obtains credit for being a fine portico, let its other deficiencies and defects be what they may. Such is most assuredly the case with regard to the extravagantly cried-up portico of St. Martin's, which is so far from possessing any unity of design, that it rather exhibits two decidedly opposite styles brought into violent contrast with each other, the inner elevation* forming the back ground to the external one or Corinthian hexastyle, being the very reverse of the latter in character and taste—positively barbarous in comparison with it. To say the truth, as usually treated, a portico is little more than an arrant plagiarism, and as frequently as not betrays equal sterility of imagination and vulgarity of taste, there being nothing at all in common between such pretentious feature and the building to which it is applied, but to which it does not seem at all to belong. Thanks, however, perhaps to the intense vulgarity and dulness together of many things of the kind, the portico-mania which prevailed some years ago, has latterly subsided. Nothing could be more desperately dull and dowdy than the majority of the things of that kind which were then perpetrated, when in order to provide for what after all looked no better than an excrescence, if not actually an encumbrance, all the rest was left quite bare or nearly so, instead of being decorated and finished up in accordance with the other. Thus instead of encouraging architectural design, the application of ready-made porticoes became a substitute for it; and instead of improving the appearance of the buildings themselves, they were actually the cause of their being left more bare and poverty-stricken than they else might have been without at all greater cost being incurred.

A portico is so decidedly a feature of parade, and such a direct avowal of pretension to classical dignity of manner that unless the latter can be fully maintained, it is what had better not be attempted; and in regard to convenience such architectural appendages are in general so exceedingly deficient in depth that so far from affording adequate shelter at the entrance to a building, they rather express the want of it, by making it too evident that what seems to be thought requisite is not obtained. In order to be effective a portico demands depth and spaciousness of plan; yet it is very rarely indeed that they can be—at least, are afforded, which becomes an additional reason wherefore things of the kind should be reserved for suitable occasions—for those rare opportunities when they can be treated with gusto, and made to partake of the poetry of the art.

The façade of the Fitzwilliam Museum answers truly to the latter character, nor is there aught of the ordinary and prosaic to disturb the impression produced by the general composition. As the front or external line of the plan, it consists almost entirely of columniation, regularly disposed (all the intercolumns being equal throughout), yet so as to combine play and variety with continuousness, in which respect we consider this design to be an improvement upon Schinkel's façade of the Berlin Museum,—we know not if Basevi took a hint from it,—which is too much of a mere colonnade (eighteen columns in antis), and would be rather tame and monotonous were not some effect thrown into it by the disposition and decoration of its background and interior. In the Cambridge edifice the projecting octastyle and its pediment are now so well proportioned to the rest, and maintain such superiority in the composition that more probably would have been lost than gained had the extent of front been greater, unless the whole could at the same time have been on an enlarged scale, so as to obtain increase of height as well as of length. For although extent of façade is generally held to be a positive merit, it may be carried to excess; and when it exceeds a certain ratio as compared with height, instead of at all conducing to grandeur, is rather apt to induce littleness of manner, as may be seen by the façade of the unlucky National Gallery, where in order to give due importance to the portico as the main division, the architect broke up the rest into insignificant parts; besides which, its length—or, speaking

* It is to be wished that this inner front wall were refaced and subjected to such "refacciamento" as would bring it into something like keeping with the character indicated by the order of the portico: the central doorway which although arched, is not loftier than the others, looks quite depressed in consequence, as compared with them, and altogether evidences most vile and barbarous taste.

of a façade, the correct expression would be its *width*—causes that building to look lower than it otherwise would do.

The Fitzwilliam façade, on the contrary, presents itself to the eye as a whole, sufficiently consistent and compact, without too much of mere repetition of parts; and the lateral extension of the portico, in immediate connection with the octastyle, produces a peculiar richness of columniation that instead of being increased, would rather have been impaired had those parts been carried on further so as to be equal to or wider than the octastyle itself, because in such case the arrangement would have resolved itself into the somewhat hackneyed one of a portico between wing colonnades. There is indeed one fault—or if it be not positively a fault, it is what might have been managed greatly for the better, as in our opinion it decidedly would have been, had insulated square pillars been substituted for the two columns behind the extreme ones of the prostyle, (which alteration together with the further one of pilasters, instead of attached columns, we have made in the sinister half of the ground plan). A square instead of a circular shaft at those re-entering angles would not only have produced the appearance of greater solidity, but have conformed better with the junction of the entablatures uniting at right angles. Another advantage gained would have been that of increased variety, and the other columns would have told all the more forcibly in consequence of the contrast so produced. Neither could it by any means have been called a caprice, or have been said to have been done for the mere sake of novelty, the motive for it being sufficiently obvious and legitimate. Rather would there have been a decided expression of intention, inasmuch as those two pillars or pilaster-piers would have plainly demarcated the three divisions of the general colonnade, whereas it now looks as if the architect had at first intended to carry it in a single line the whole way, and afterwards thought of breaking it, by advancing an octastyle crowned by a pediment. There would besides have been more of unity of design in one respect, because each of the lateral divisions would have been in antis, and the composition would thereby have gained in distinctness of articulation.*

It deserves to be remarked that though the shafts of the columns are plain, the pilasters are fluted—quite contrary to Grecian practice, in which a similar degree of contrast and distinction was produced by a precisely reverse mode of treatment; while in the Roman and modern styles the principle of uniformity has generally been followed, and columns and pilasters made, either plain or fluted, alike. Each of the three modes has something to recommend it, and it may therefore be left to circumstances to determine which is best suited to the particular design or occasion. In support of that here adopted, it may be argued that the principle of contrast being assumed, there is very sufficient reason for bestowing what constitutes it upon that which most requires it. Although left quite plain, the shafts of insulated columns always express themselves to the eye with sufficent distinctness; whereas, the faces of pilasters upon a wall require something to distinguish them from the general surface, without which they show themselves very feebly, and chiefly in their capitals and bases, which thereby become spots. The requisite difference of surface between that of the wall and the pilaster faces, is hardly to be obtained except by one of two modes, that of rusticating or showing the *joints d'appareil* of the wall, or fluting the pilasters, which thereby acquire richness as well as distinction, and are made, in artistical phrase, to "hold colour." Difference of application demands difference of treatment; the Greeks employed pilasters merely as antæ at an angle of a building, or at the ends of the side walls inclosing a portico *in antis*, where they exhibit themselves not only plainly but forcibly; whereas, as decoration upon a wall, pilasters require to be relieved from it. In the building under notice this is done by fluting them,† notwithstanding that the shafts of the columns are plain, wherefore it may be thought that, in comparison with the latter, an undue degree of decoration is bestowed upon the pilasters; yet, independently of the reasons already alleged for it, the greater richness conferred on the pilasters is no more than what serves to equalize them in importance with the columns. Still it strikes us that in this instance a very good though unusual effect might have been produced by fluting *some* of the columns, viz., the eight in front beneath the pediment, whereby the octastyle would have been distinguished from the rest of the colonnading, and the columns in that division of it would have been decorated in accordance with the pilasters at the extremities. Nay there is direct precedent for the combination of fluted or plain columns, not only in the same design but almost in juxta-position with each other, namely, in the beautiful loggia forming the north-west angle of the Bank,—a composition distinguished by picturesque effect of the most striking and sterling kind.

The portico of the Fitzwilliam Museum exhibits kindred taste—some of the best quality of that work of Soane's, without the tincture of *Soaneanism*. It is full of perspective effect, mainly produced by arrangement of plan, which, though apparently complex, is not at all *tourmenté*; on the contrary, exceedingly simple, it being in three divisions in both directions, *i.e.*, upon both the longitudinal and transverse section, through the portico. The first gives us the body of the portico and the two lateral colonnades; the other, the projecting octastyle, the lateral colonnades, prolonged to an avenue extending through the building parallel to its front, and the recessed portion corresponding with the projecting one. It is this beautiful combination of plan, in which regularity and variety, harmony and contrast, are all united, which constitutes the surpassing merit of this portico. Its external design is the least part of its merit; and even in regard to plan, it would have been of a superior kind even had it been less perfect, complete, and symmetrical than it now is. Do away with either the projecting or recessed portion of it, and it would lose half its peculiar charm; or had the colonnades terminated against the masses which form the extremities of the elevation, or else been continued by another open intercolumn instead of a closed one, while the façade itself would have been impaired, two most charming effects would have been entirely lost, *viz.*, those of vista, whether as seen from end to end on approaching by one of the side entrances, or on entering through the octastyle in front, when that *transept* suddenly reveals in the most captivating manner. The promise made by the exterior is found to be more than fulfilled by the interior of the portico, which is, in fact, so replete with effect as to be all *picture*, and at every step some fresh combination of perspective lines and of light and shade is produced: no single view, even were it the very best that could be selected for giving some general idea of it, could do more than convey an imperfect because necessarily a very partial and limited one. However, we should have been glad of even something of the kind in the "Memorials of Cambridge," where it would have formed a most interesting illustration; whereas only the façade is shown, and that in such manner that the effect attending the interior is very poorly expressed. Still in one respect the Fitzwilliam Museum has been more honoured in that work than any other structure in the University, it being almost the only one on which anything like satisfactory architectural description is there bestowed. Possibly this may have been in some measure owing to there being nothing but the building itself to speak of,—no ready-made history, or history at all, belonging to it; and perhaps it was considered indecent to make the article a mere peg for *hanging* Earl Fitzwilliam upon it in effigy, *alias* in memoir.

If our remarks have been somewhat *in extenso*—not, we hope, prosingly prolix—we are not likely to be equally diffuse again in a hurry on a similar subject. Very few things indeed of the kind afford aught for either description or comment. Our modern Anglo-Grecian and Roman porticoes are, for the most part, the merest architectural humdrum imaginable. We may fairly apply to them what Pope said of women, namely, that they "have no character at all;" though book-makers and guide-books are ready enough to extol every "four-posted" production as "a fine portico!"

In conclusion, we may express the hope that the gentleman to whom the completion of the Fitzwilliam Museum has been confided since its architect's death will adhere to his intentions, for he is not very likely, we conceive, to improve upon them. Most assuredly, he has never yet conceived anything at all comparable to that façade and portico.

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* In the portico of the Royal Institution at Manchester, which we might have before observed is so very similar in composition to that of the Fitzwilliam Museum, that the idea of the latter seems to be derived from it, Barry has boldly defined the junction of the lateral loggias and prostyle, the point of union being a pier, whose solidity is increased by antæ pilasters backing the extreme columns of the prostyle (an Ionic hexastyle) and flanking those of the loggias. That building may therefore be quoted as affording an example of picturesque combination, and a highly favourable exception to the equally insipid and common-place things constituting the majority of the class. We regret that having no plan of it, we are unable to say how far in that respect it differs from or is inferior to the Fitzwilliam.

† Barry, who has true artistic feeling for effect and finish of detail, has fluted—and, no doubt, with reason to himself for what he was doing—the pilasters to the windows in both fronts of the Travellers' Club House. Apropos to which we may observe that we dissent from the opinion which has passed unqualified condemnation on the practice of decorating windows with columns, pilasters, and pediments. We cannot pretend to justify the propriety of it here in a note, therefore content ourselves with remarking for the present, that if it be contrary to sound architectonic principle, we must abate our admiration of Gothic, in which nearly all the minor features and decoration in general are made up of forms borrowed from and repeating those of the principal members of the structure.

STAINED GLASS WINDOWS AT SAINTE CHAPELLE, PARIS.

(Paper read at the Royal Institute of British Architects.)

By A. Poynter, Esq., Hon. Sec.

The excellent restoration now in progress at the Sainte Chapelle, in the Palais de Justice, at Paris, has caused it to be lately mentioned in this room on several occasions, on one of which a wish was expressed by some of the members present, for a more particular account of the stained glass with which the windows are decorated, and which, notwithstanding some serious dilapidations, has remained, on the whole, more perfect perhaps than any similar work of the 13th century. I fear the subject will scarcely prove so interesting as may have been anticipated, owing to the want of the illustrations necessary to do it justice; the development of the details, to any great extent, being obviously a work of time and labour. The Sainte Chapelle, it need hardly be repeated, was built by St. Louis in the 13th century. Previously to the restoration of the polychromatic decorations of the interior, the Sainte Chapelle attracted little attention from our travelling students. The decorations had either disappeared or were covered up behind the cases and presses with which the chapel was filled, in order to fit it up for a depository of records connected with the Palais de Justice; and this use to which it was put was a sentence of exclusion to strangers from the interior, seldom remitted. I was however fortunate enough, some years ago, to penetrate into this mysterious sanctuary, and at my leisure to make notes on the stained glass, (at that time the only object worthy of study which the chapel afforded,) the results of which I am about to submit to you.

The Chapel contains sixteen windows—four on the north side, four on the south, and seven in the apsis, which forms the eastern termination of the building. These are all the original windows; the sixteenth is a rosace at the west end, which has been restored, both stone work and glass, in the style of the Gothique flamboyant, probably not earlier than the middle of the 15th century. The side windows are in four lights each, with circles and tracery in the heads, and the windows of the apsis in two lights, the compartments being extremely lofty in proportion, as is usual in the French Gothic. The iron work of these windows, forming the frames of the compartments in which the glass is arranged, is well worthy of attention for its beautiful and varied form of composition, producing, in the tall spaces which it occupies, an effect which in some measure supplies the place of tracery. This is especially the case with the third window on the south side, which will be further noticed in its turn.

In the state in which the chapel was when my notes were made,—and indeed as it may be still, for I believe the restoration has not yet arrived at the glass,—many of the lower compartments of the windows, hidden behind the presses for the records, were destroyed. Some of the glass was probably abstracted when the presses were fixed, and it was unknown what had become of it; but it is probable, from the confusion which exists in some of the windows, that a portion may have been taken to make good defects in those parts which remained visible, for in one or two places, which will be noticed in their turn, the glass has been much damaged, and badly patched up; but these losses are small in comparison with what remains in a high state of preservation, and which may be stated to amount to about 800 compartments, representing subjects of scripture history, and containing from two figures each, up to as many as nine. The total number of figures may amount to between two and three thousand on the most moderate calculation. They exhibit nothing remarkable either in drawing or composition beyond the art of the period; on the colouring there will be some observations to make presently. The grounds and borders of the lights are more worthy of attention. The fleur-de-lis and the arms of Castile, in reference to Blanche of Castile, the queen of Louis VIII, and mother of the king by whom the edifice was founded, are conspicuous throughout these details.

The first window on the north side (to take them *seriatim*) is one of those which has suffered most wrong from time and violence. Part of the more modern erection of the Palais de Justice is built close against it, so that the light is shut out, and the glass is either entirely destroyed, or so patched up where it has been kept in its place as even to render the subjects undistinguishable. The iron work of this window is arranged in circles and semicircles. (Fig. 1.) No. 2, on the north side, contains seventy-two compartments above the line to which the presses formerly reached—eighteen in each of the four lights, besides those in the circular compartments of the heads; the compartments are disposed in the form of lozenges and portions of quatrefoils on the iron frame shewn in fig. 2. The subjects are all from

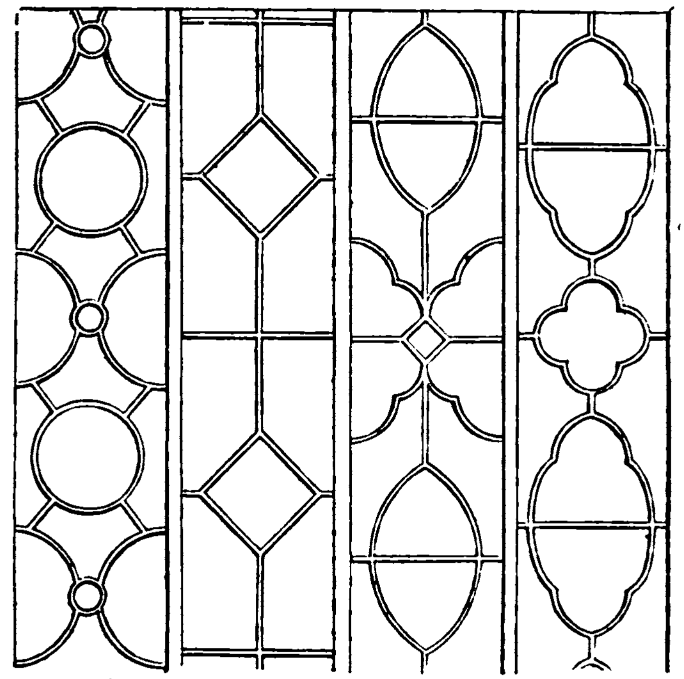


Fig. 1. Fig. 2. Fig. 3. Fig. 4.

the book of Exodus and in high preservation throughout, except that, in some repair, the drowning of the Egyptians has been turned the wrong way upwards. The ground of this window is a sort of trellis, not very remarkable, with a border of the arms of Castile.

In the third window fifty-six compartments remain above the press line, arranged in portions of quatrefoils, and in the vesica piscis form (fig. 3), each of the latter containing two subjects; the eight lower compartments represent coronations of the kings of France, and more remained at the time these notes were made, behind the presses, which are now brought to light. In the upper part is contained the history of Moses, who is introduced into most of the groups. Among these subjects the plague of flies is represented with the most amusing *naïveté*, the faces of Pharoah and his court being covered with the insects after a fashion which renders the subject quite unmistakeable. The ground of this window is magnificent, being entirely *semé* of fleurs-de-lis, with medallions of Castile. It is to be regretted that it should be placed in the north side of the chapel, from which circumstance, and from being pressed upon by the Palais de Justice, it has not the benefit of a due share of light. The border is not so remarkable. The whole of this window is also in high preservation.

No. 4 exhibits thirty-six compartments, very elongated quatrefoils, each divided into two subjects, with quatrefoils of the ordinary form between. (fig. 4.) The subjects are principally from the book of Joshua, and for the most part represent battles (certainly not of the crusades of St. Louis, as a French artist has supposed), among which the fall of Jericho is conspicuous. Most of the compartments are in high preservation, and it is unnecessary to say that the Israelitish warriors are clad and armed in the fashion of the 13th century. There is nothing very remarkable either in the ground or border of this window, except that the sun and moon are introduced in the heads of the lights.

All these windows contain nine compartments in the heads—one in each, of the curves between the circles, one in the sixfoil light of the middle circle, and one in each of the quatrefoils, which compose the tracery.

The first of the seven windows of the apsis is filled with plain rectangular iron work (fig. 5). This is one of the windows which has suffered the most dilapidation, and only some of the lower panels remain entire. Among the surviving subjects is Sampson, with Dalilah cutting his hair. The head consisting, like all those in the apsis, of three trefoils, contains a cherub in the upper trefoil, and an angel in each of the others; these figures are in circles inscribed within the trefoils, and the surrounding spaces are filled with the arms of France and Castile.

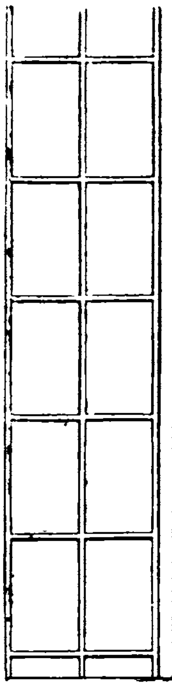
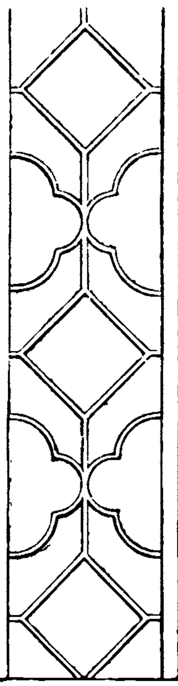
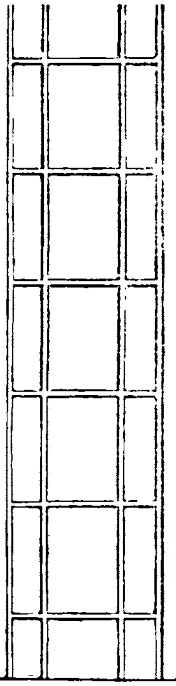
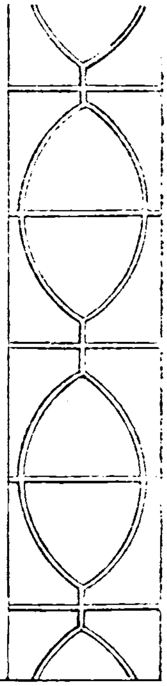





Fig. 5. Fig. 6. Fig. 7. Fig. 8.

The first light of the second window in the apsis is in sixteen compartments—lozenges and half-quatrefoils (fig. 6). The subjects are generally obscure and do not appear to belong to each other; the ground, which is in figured circles crossed by a trellis, is very handsome; the border, plain red with small blue rosettes.

The second light is unlike the first, and differs totally from anything else in the chapel; it fits its place too well to have come there by accident, but the style plainly indicates its date to be the 14th century. It is divided by plain iron work into rectangular compartments (fig. 7), of which twelve remain. Each of these is subdivided into three, and the same subject, with variations, is repeated in eleven of them, viz., in the centre a throned figure, placed within the convolutions of a rich flowing arabesque, and a standing figure under a canopy on each side; the upper figure of the eleven is God the Son, the next below, the Virgin. It is evidently a portion of a Jesse window. In the centre of the upper compartment and in the head of the light the arabesque is beautifully developed, and the Dove appears among the scroll work. In the head is God the Father and two angels, filled up with the arms of Castile. The whole of this light is in the highest degree brilliant and harmonious, and in the best preservation. It is impossible to believe it contemporaneous with the rest of the glass, though how it came to be thus interpolated where all the rest is uniform in style it would be difficult to conjecture.

No. 3 in the apsis contains twenty-two compartments, in the form of the vesica piscis (fig. 8), each divided into two subjects, generally referring to the Nativity, but some do not appear to belong to the rest; some of the damage and patchwork previously noticed is to be observed in this window. In the top compartments and heads of the lights a building is represented, with figures incensing, probably the holy house of Loretto. In the head of the window is an angel, the Virgin and child, and God the Son, with the arms of France and Castile. The ground of the window is a plain trellis, with a border of fleurons.

No. 4, thirty-eight compartments, in squares and quadrants, relating principally to the crucifixion and events connected with it, with groups of saints and angels in the upper compartments. What is not actually destroyed is mostly in high preservation, but three of the principal compartments are lost and the squares filled with patchwork, and two others are misplaced. The ground of this window is a rich and beautiful trellis, with medallions of the arms of Castile, and a border of fleurons, and in the centre of each division of the four quadrants a very rich quatrefoil.

The first light of No. 5 shows eleven compartments, in lozenges, and a sort of quatrefoils (fig. 9), with a common trellis ground, and a border of very

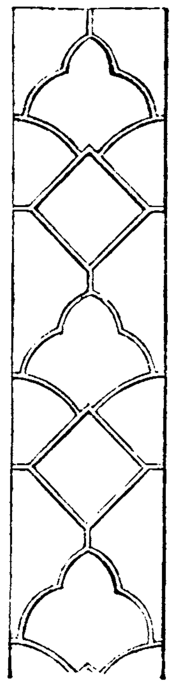
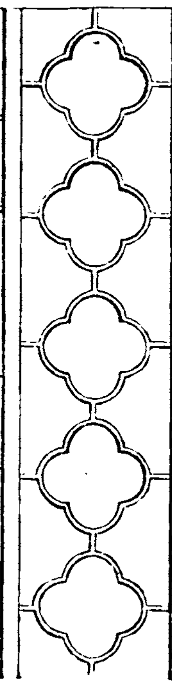
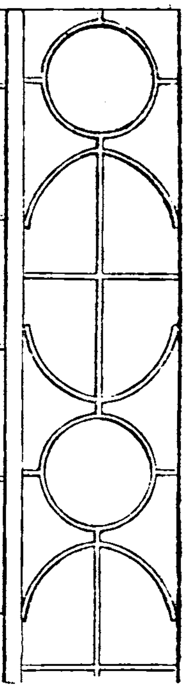




Fig. 9. Fig. 10. Fig. 11.

graceful fleurons. The second light is different,—regular quatrefoils (fig. 10), on a ground *semé* of Castile, and a sort of festoon border, rather ungraceful. The subjects are generally obscure, and apparently unconnected. The circumcision and the beheading of St. John are the only two which are obvious in the first light, and Moses with the tables in the second. In the head are three saints with the arms of Castile misplaced. This window is not in very good preservation, and the glass itself is much corroded and perished.

In No. 6 there are twenty compartments in quatrefoils, The subjects appear to be from the history of Noah, but they are for the most part obscure. This window is in rather better condition than the last; the ground and border the same as in the second light of the last window; *semé* of Castile with festoons.

No. 7, twenty compartments, in circles and half of the vesica piscis (fig. 11); the subjects obscure, but Tobit and his dog, and Daniel in the den, with a lion with a human face, are to be distinguished; the ground is a handsome trellis pattern, with a border of fleurons.

This completes the windows in the apsis.

The first window on the south side contains forty compartments, all in circles (fig. 12); the ground a trellis, with a fleur-de-lis in every square formed by the intersections. The subjects in the two first lights are from the book of Job; of course the devil plays a conspicuous part in the history, and is represented with much liveliness of imagination; the burning of Job's house is represented with edifying simplicity, his satanic majesty performing the incendiary in person. In the other two lights the subjects are not so clear; in the four top compartments are angels incensing. The head of the window is arranged as described on the north side, but the quatrefoil compartments represent buildings surrounded by arabesque work.

No. 2 on the south side is a window of extraordinary beauty; there are eighty compartments, quadrants, with a quatrefoil in the centre of every four (fig. 13); in each quatrefoil is Castile, and between the quadrants is also a medallion of Castile on a ground of rich mosaic. The subjects are various and abound in royal personages—those from the book of Esther are the most obvious. The head of this window is similar to that of the last. This window is particularly to be noticed for its rich, brilliant, and harmonious effect, aided no doubt by its position to the south. The form of the compartments, which the iron work follows throughout, fall in well together, and leave no awkward or irregular shapes in the ground. From the number of thrones and tabernacles on red grounds, there is more rich colour than usual, and this, with the repetition of the arms of Castile on a large scale, effectually balances the general blue tone which pervades this and the rest be windows.

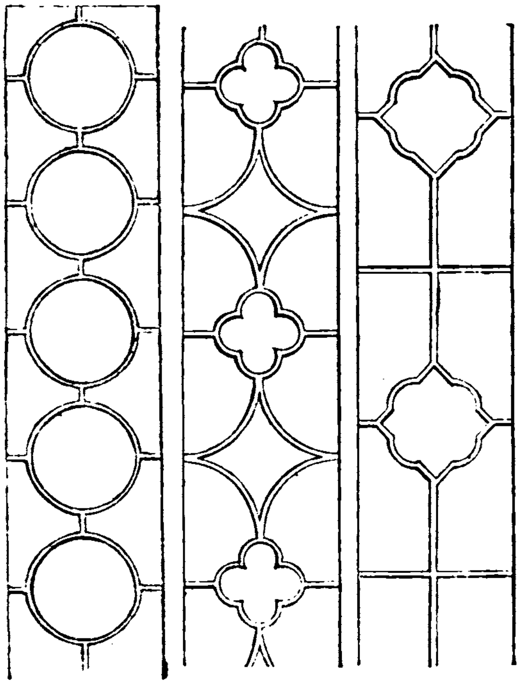


Fig. 12. Fig. 13. Fig. 14.

Notwithstanding what has been said of the last window, No. 3 on this side is perhaps the finest of the whole; the iron wörk already referred to is remarkably elegant; there are eighty compartments, the centre of every five being a very graceful compound form (fig. 14), and as they fill very nearly the whole space without interstices, the colours, of which a great proportion is very rich, are spread without any inharmonious spots. King David figures as the princpal personage in the history illustrated by this window. What little ground there is, is a mosaic, and it is remarkable that the border, which is in fleurons, is the poorest of the whole set. This window is in good preservation generally, but not altogether so perfect as the last.

No. 4, the last of the series has all the appearance of having once been a brilliant window, but it is in bad condition and patched to confusion. The form of the iron work and disposition of the compartments are the same as No. 4, on the other side. There is a large building represented near the centre of the window, which judging from others of the subjects, the priests carrying the Ark for instance, may be conjectured to be Solomon's temple. The ground of this window is particularly fine, diapered circles with the fleur-de-lis in the centre, and Castile in the spaces between.

It is to be feared that this description will have conveyed very little idea in the absence of illustrations, of anytbing beyond the quantity of matter contained in this glass, and the pains with which it has been elaborated. It may be well to add a few words on the effect produced. Every one is familiar with the blue tone of the early style of stained glass, arising from that colour being almost exclusively used in the back ground of the compartments. Such is the case with the glass of the Saint Chapelle, and as the harmony of the general effect is supported by the introduction of a preponderance of the same colour in the general ground works of the lights, this tone prevails very greatly through the whole surface of the glass, reds, greens, and violets, with only a small proportion of yellow, flesh colour, and other light tones, forming the reliefs and contrasts. The glass therefore admits but little light, and on the north side under the influence of sunshine on the opposite side, fails even in its effect of transparency, a result which must have been noticed by all who have had the opportunity of examining glass of this kind under different aspects. It appears, however, from the restoration of the Polychromatic decoration, of the authenticity of every part of which, I believe, no doubt can be entertained, that the architects of the Middle Ages were well aware of this inconvenience, and took very good measures to counteract it, the stonework of the windows being coloured of a sort of deep maroon; and the effect of the glass set in a framework of this tone, is something very different from its appearance between jambs and mullions of dead white as it is most generally seen, and as it really was in this instance, when my notes were made. The confusion which results from the collocation of such an infinite number of small pieces of coloured glass as we find in the compositions of this style, has been sometimes considered one of its beauties, and we hear glass commended because it looks like Turkey carpet. This is certainly the case with the glass of the Sainte Chapelle. The first impression conveys nothing to the eye or the mind, but the unmeaning variety of the kaleidoscope—but let it be observed, that to produce this effect with distinctness is no small triumph of the art of the collocation of colours. And here a remark may be made upon the general belief that there is some extraordinary quality in the colour of the ancient glass. That it is so in many cases is unquestionable, since the fact has been recognized by those who are practically acquainted with the manufacture of glass; but there are instances, and the Sainte Chapelle is one, where much of the red glass is far from being of a good quality; but this is by no means perceptible on a general view, and it proves that the brilliancy of the old red glass depends no less upon its collocation and the effect of judicious contrasts than upon the individual character of the colour. To return to the glass in question, if the forms are confused, the colours are not confounded; and when it is considered how easy it is by the injudicious disposition of small surfaces of transparent blue and red, to fuse them into a general effect of purple, of all results the most disagreeable and inharmonious, we must admit that their art was well understood by those who combined them, as they were combined by the glass painters of the 13th century; and it can hardly be doubted that the result produced was that calculated upon by those artists, viz., the effect of a rich and harmonious *coup d'œil* at the first view, heightened by the obscurity and mystery enveloping the details which a more deliberate survey and examination brought to light. If this were really their purpose, their success is undoubted. Whether this be the best mode of treating stained glass is another question altogether, and opinions may differ upon it. Stained glass was certainly very differently treated when it became combined with fine art, a quality to which the early glass can make no pretence. Perhaps the later Flemish and German glass displays the greatest perfection to which this art has been brought, exhibiting a combination of the qualities of good drawing and composition, with those conditions which are indispensable in glass painting, and separate it altogether from the art of painting on canvass.

One of these conditions which was never neglected as long as glass painting was understood, and which will be found invariably attended to in every successful specimen of stained glass, whether ancient or modern, is the profusion of detail. The earliest and the latest glass, however differing in every other respect, possess this in common. In the glass of the 13th century this quality is produced by the minuteness of the parts. In that of the 15th when the large treatment of the subjects necessitated large masses of the same colour, it is obtained by the introduction of diapered grounds, or sometimes by the minute elaboration of the draperies. It is not enough that this diaper work should be introduced when the eye can distinguish and appreciate it; in the old glass it is developed in situations, and on a scale, where it is inevitably thrown away, except in contributing to the general effect, which would as inevitably be marred by its absence. The rosace at the west-end of the Sainte Chapelle to which reference was made at the beginning of this paper, is a strong instance of the truth of these observations, so far at least as regards the practice of the Middle Ages. In this rosace there are eighty-one principal compartments containing a series of subjects from the Apocalypse, of which about sixty-six remain entire. The style in which this glass is executed exhibits the strongest possible contrast with that of the older series—there is very little colour of any kind—instead of strong contrasts the effect is brought out by chiaro-scuro. In which colour there is the predominating tone is yellow, but there are vigorous touches of red of great value to the effect. There is of course none of the depth and richness which characterize the original windows, but there is a transparency, and a sparkle, scarcely less imposing in its effect, and when to this first impression succeeds the examination of the detail, a proficiency in drawing and composition is developed, united to a refinement and delicacy of execution which can be fully appreciated only by means of an opera glass, and which might be thought thrown away, did experience not prove the elaboration of the detail, whether in one form or another, to be the one thing needful to the full effect of stained glass.

A few words may be added in conclusion, on the phlychromatic duration already referred to, by which this gorgeous display of transparent colour is harmonized and supported; every portion of the interior surface of the Chapel is covered with the richest and most positive colours, relieved by gold. The shafts of the columns, both principal and subordinate, exhibit the brightest vermilion and green, the vaulting shafts, which present the largest surfaces, being broken up by gold lines, disposed in various patterns; the lines themselves being embossed and minutely diapered, and the intervals filled with the embossed arms of France and Castile. The removal of the presses has revealed a magnificent dado, resembling that in Westminster Abbey and other buildings of the period; the back ground elaborately diapered and all the foliage gilt. In the spandrils of the arches are sculptured angels on grounds of blue enamel, diapered with gold. As the dim religious light admitted into the building is too feeble to prevail against the immense mass of colour, an ingenious and successful device is adopted to supply the place of light and shade in the sculptured details, and to give them the sharpness in which they would otherwise be deficient, by defining the edges of the foliage with a thin black line. Against the pillars are brackets destined to receive statues, some of which are restored, but not yet placed; they are all of that superior class of sculpture as compared with contemporary works elsewhere, which marks the French school of the Middle Ages, and are elaborately decorated with enamel and jewels. The only part of this splendid interior not perfectly satisfactory is the vaulting, of which the plain blue ground *seme* of *fleurs-de-lis* is too simple for the rest, and from this observation must be excepted the apsis, where a border round each compartment affords the necessary relief. Under the Chapel is a crypt or sub-Chapel, partaking of the same style of decoration, but not yet restored.

CANDIDUS'S NOTE-BOOK.
FASCICULUS LXVIII.

"I must have liberty
Withal, as large a charter as the winds,
To blow on whom I please."

I. Of all the ancient orders the Grecian-Doric is by far the most intracticable—almost to impracticability, although it has been largely introduced into practice in this country. By impracticability is to be understood not any difficulty as to construction or execution, but the impossibility of applying it consistently or naturally in buildings which are altogether differently constituted from those in which it was originally employed. It is so obstinately stern and inflexible, and so strongly marked in character, that it will suffer nothing else to come in contact with it. Nevertheless it has been patched up with, and patched upon, everything, Gothic alone excepted. So long as the mere columns and entablatures have been *correct*, that is, mechanically-produced fac-similes of some ancient example, and so far, bearing nominal resemblance to Parthenon or Pæstum, the most excruciating violations of the style have been tolerated—why do I say tolerated?—they have even been regarded with self-complacent wonder; and because we have copied it piecemeal, we have given ourselves credit for appreciating and relishing the severe simplicity of that order. Though it has been repeated *ad nauseam*, in hardly any one instance has the sentiment of the style been fairly expressed; and notwithstanding, too, the lackadaisical prating about "proportions," very rarely is any kind of proportion at all observed between the order itself and the structure to which it is applied. Instances have occurred before now, where otherwise very plain ordinary buildings have, the in attempt to give them something of style, been crushed into insignificance by huge Doric columns of greater diameter than the breadth of the openings for windows; while, in others, the same order has occasionally been reduced to minikin dimensions, and applied as decoration to subordinate parts of the general mass; which is surely a very great mistake, there being nothing whatever in the constitution of the Grecian-Doric—an order rigidly expressive of architectonic purpose and nothing more, and possessing no elements of combination and variety—to recommend it for purposes of embellishment. There would be something rational in taking the order merely as a type to be modified according to the exigencies of the particular design, and if needs be, even enriched. But no; that must not be thought of,—that would be quite illegitimate, and would be reprobated as "tampering with the orders," whereas the abusing or misusing them by preposterous mis-application is, it seems, perfectly legitimate and *secundum artem*; though, in my poor opinion, an architect may as well give us columns of his own invention at once, as mar the effect of an ancient order by joining it on, and mixing it up with, what does not at all agree with it. At the worst, were the invention bad, the whole work would be as likely as not to be of a piece throughout; at any rate the genuine and classical would not be degraded by being made to associate with the vulgar and mean. Architects should learn to rely more upon themselves for detail, and less upon their barefaced and wholesale borrowings, which borrowing system has, if nothing else objectionable in it, this unlucky tendency—that it relaxes industrious study, and renders architects prone to rely upon the merit of what is not their own, as excusing the bad that really belongs to them.

II. It would seem that professional men, who may be supposed to have studied the orders thoroughly, can do no more with them than those who are not architects. Just as they find them ready prepared to their hands, so do they make use of them, without any more ceremonious process of appropriation than that which is expressed by the euphuistic term "abstraction." Perhaps their study of them is not of the most fructifying kind: to learn to talk learnedly about dates and the histories of styles, and to know to the fraction of an inch all the dimensions of the Parthenon, is a very different matter from understanding architectural design; knowledge of the former kind constitutes for the architect only the materials for and aids to his proper artistic study. After all our so-called study of Grecian architecture, what have we made of it? Have we acquired from it the power of producing anything in congenial taste? With copying we began—which was excusable enough,—and with copying we go on, and are likely to do so to the end of the chapter, till we lay it aside altogether, for we do not care to take the first step towards any advance beyond the mere copying point. Truly, we have most singular notions of studying the antique, for we learn nothing more from it than what lies on the immediate surface, and mimick rather than imitate it; nor do we even avail ourselves, as we easily might do, of the varieties of the Greek orders which the Greeks themselves have left us. Have we as yet even so much as *attempted* to turn to account the idea for a four-faced Greek-Ionic capital, held out to us by that singular example in the temple of Apollo, at Bassæ,—an example, perhaps, all the more valuable because it is suggestive of further improvement? We seem to search out and accumulate examples only in order to bury them again in museums and in books. There are a few charming specimens of antique inventions for capitals in the British Museum, but for any use that is made of them they might about as well be at the bottom of the Thames at once. Has any service been rendered to architecture practically by the specimens lately discovered in Asia Minor by Texier, (who, oddly enough, was sent out thither by the French government, for the French make no use of the Greek and Asiatic orders,)—has a single idea been adopted from them?

III. If it may be judged of in its present state, Cockerell's building for the new Bank at Manchester does not promise to be any great architectural achievement. It may not unfairly be said to exhibit a sort of *travesti* Greek style, a Doric order, borrowed from that of the temple of Nemesis at Rhamnus (the shafts of whose columns are fluted only just at foot and top), being employed not for the entire elevation, but merely as decoration to the lower division or ground floor, in three-quarter, consequently, attached columns, and so wide apart (for there are five triglyphs over every intercolumn) as to be totally contrary to Greek ideas of proportions for intercolumniation in that order. Greater conformity to characteristic proportions might have been expected from one who descants so fluently *ex cathedrâ*—more fluently, perhaps, than perspicuously—on the doctrine of *proportions*. However, such violation of strict architectural *Dorism* is not greater than that of filling in the three centre intercolumns with large *arched* triple or Anglo-Venetian windows. The upper part of the front will be a sort of heavy Attic, of which the merit may be that it is unborrowed. It could be wished that the order had been equally nondescript, for then the whole would have been stamped by greater originality—at least, greater consistency; and whatever his invention for the purpose might have been, the Professor could hardly have been a degree more heterodox than he has been in the use which he has now made of Greek orthodoxy.

IV. One of the objections raised by way of answer to what I said in regard to a church being lighted on its sides by clerestory windows alone, does not apply either to Mr. Wightwick's building, or the other mentioned by me, because that circumstance does not, in either instance, in the slightest degree affect external character, no part of the exterior being visible except the front. Windows are so expressive in a Gothic church, and design depends so mainly upon them, that to erect an insulated structure of the kind, without other windows on its sides than those of the clerestory, might be deemed improper and perfectly arbitrary; not that I myself should despair of something good as well as striking being produced without any windows below. But did I in what I said, go to the extent of recommending the banishment of side windows, except clerestory ones, from churches? I think not; at least, I did not intend to do so, and therefore, I suppose, expressed myself very muddy-headedly. But what Mr. Wightwick has done is—oh horrible!—not according to precedent. Now ten thousand maledictions upon that said "precedent"—or rather the servile doctrine founded upon a blindly superstitious reverence for it,—doctrine that entirely denies to art the power of further production; or if it does chance at any time to throw out or begin to throw out a fresh shoot, it must be extirpated at once. What is good requires no precedent to justify it, and what is bad is not to be justified by a thousand precedents in support of it, for if the latter be in themselves good, they rather convict the thing that appeals to them of departing from their spirit. Your precedent-mongers do not even know whether they ought to admire or censure what is shown them, until they refer to authorities. Tell them that such or such idea is quite new, and they will instantly begin to frown, although they may just before have seemed disposed to relish; or, on the contrary, they will, on hearing that there is valid authority for what appears to be quite a novelty, be instantly propitiated in its favour, yea, even though an energetic "Damnable!" were actually hovering upon their lips. The present overweening reverence for precedent in some quarters, is likely to prove the *Dry-rot of Art.*

PRESSURE ON RETAINING WALLS.

SIR—In your remarks, at Page 109 of the *Civil Engineer and Architect's Journal*, on a paper of mine on the pressure to which retaining walls may be subjected, a *necessary* preliminary investigation has, apparently, been mistaken for one on retaining walls. The subject was *pressure*, not retaining walls; and you may have seen from the conclusion of the paper, and other parts of it, that it was merely introductory.

It is best to calculate the pressure free from all considerations of momentum at first, because when once this pressure is determined, it can be readily applied to the determination of the strength, &c., required in a retaining wall, so as it may resist being overthrown, being moved forward, or being fractured, by the resultant of its own weight and this pressure.

Mere formulæ without calculations from them are, to the practical man, nearly useless. I have therefore given tables of *pressure;* but tables of *momentum* would, in my judgment be useless. Telford gives pressure, *not* momentum, very properly; and gives separately the leverage, or the position of the centre of pressure; I have not done so, because it was not necessary to do so in this part of my subject, and because, also, any analytical determination of the position of the centre pressure must depend a good deal on an hypothesis, which may be considerably modified by the manner in which a wall is brought up and the filling behind it. Friction at the back of the wall belongs also, most properly, to the next part of my subject.

The formula $\int p\,x\,dx$ is a correct representation of the momentum, but to make it useful, take $p = w\,(h - x)$, a fraction of x, the height h, and a known quantity w: we find then, by integration, &c., the momentum $m = w\left(\frac{h\,x^2}{2} - \frac{x^3}{3}\right) =$ (when $x = h$) $\frac{w\,h^2}{2} \times \frac{h}{3}$ and, as it is easy to show that $\frac{w\,h^2}{2}$ is the pressure, $\frac{h}{3}$ is the leverage; but there are many circumstances in practice which may alter the position of the centre of pressure, whilst the pressure itself remains unchanged.

With respect to the conclusion of your remarks, I believe you will find on a re-examination, that I am *not* mistaken here. I have benefitted a good deal by the study of Telford's works, and if I have pointed out some of his mistakes—which every investigator is subject to—it was for the purpose of warning those who, not being disposed to investigate for themselves, may adopt them without consideration. The mistakes of such men as Telford are doubly dangerous, from the position which his works justly hold.

May I request insertion for this in your next number.

I am Sir,

Your obedient servant,

Dundalk, April 3rd, 1846. JOHN NEVILLE.

[Mr. Neville having stated his intention of completing his memoir in the particular to which we alluded, there now remains but slight difference of opinion between us. We still, however, are unable to assent to the expediency of considering the resistance and the moment of it separately. Mr. Neville says, "there are many circumstances in practice which may alter the position of the centre of pressure, whilst the pressure itself remains unchanged:" he could not have made an admission more in our favour, for this shows that the determination of the pressure by itself adds absolutely nothing to our stock of knowledge.

In the case taken in the present letter—and, indeed, in all other cases, where the sum of the pressures varies as h^2 or the square of the distance from the top of the wall—it is easy enough to find the centre of pressure, because the pressures themselves follow a known hydrostatic law. But in some of the most important cases the pressure does not vary as h^2: for instance, the equation 8, page 4 of Mr. Neville's memoir, which refers to one of the very commonest cases, that of a wall supporting a bank sloping upwards behind it, gives an altogether different law. We do not at present see how it is possible to ascertain the centre of pressure in this instance. (The result, by the way, is identical, *mutatis mutandis*, with equation 453 in Moseley's "Principles of Engineering," and Mr. Neville's investigation, though more general, has the advantage of much greater simplicity.)

Is there not an error in equation 28, page 11 of the memoir? Putting $\delta = 0$ (that is, supposing the upper surface of the bank inclined at the angle of repose), the right-hand side of the equation vanishes, and, consequently, on the left-hand side $c = \phi$; which leads to the strange conclusion that, when the upper surface is inclined at its natural slope, the plane of fracture is parallel to the plane of repose. At the top of the next page, Mr. Neville gives a definite value to the horizontal pressure when the wedge of earth is resting on a plane of repose. But surely, by the principles of the inclined plane, when a body rests on a plane inclined at angle, of which the tangent is the co efficient of friction, the body will have no tendency to slip forward, and cannot, therefore, require an additional horizontal pressure to support it.

We scarcely know what is meant by the allusion to Telford in the present letter, unless there be an accidental mistake of his name for that of Tredgold;—we said, last month, that Mr. Neville had condemned the latter from having misunderstood his meaning. On referring to Tredgold's original paper, we find his conclusion to be in effect this,—that if the sloping bank be carried up so high that the plane of fracture meets the natural slope of the upper surface, all the pressure on the wall is caused by the wedge, included by the plane of fracture, the wall, and the upper surface: in other words, however high the bank of earth may be, the additional height, beyond the place where the plane of fracture meets the surface of the scarp, adds nothing to the pressure on the wall. Mr. Neville says this conclusion is erroneous! But a moment's reflection will show that all the earth behind and above the plane of fracture is in a state of rest by itself, and cannot possibly add to the pressure on the wall. Tredgold further says that if we were to adopt the now exploded doctrines of Belidor and Rondelet, we should get a different and an absurd conclusion. This is all perfectly correct. Tredgold is not infallible, but he ought not to be blamed for errors committed by others—he has plenty of his own to answer for.]

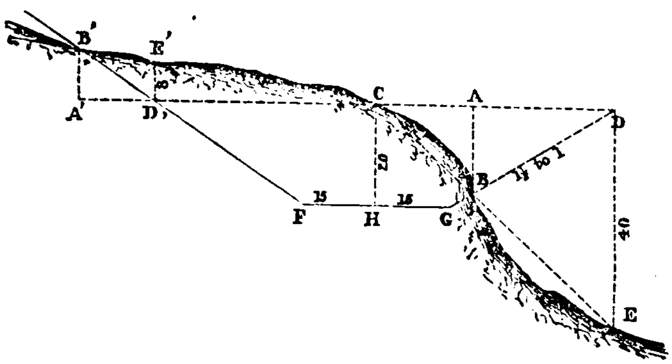
SUBSIDENCE OF THE PRESTON VIADUCT.—This viaduct consists of 27 arches, and it crosses the turnpike road from London to Brighton, near the Brighton terminus. It has been finished several weeks, and the principal portion of the wooden centres supporting the arches taken away.—April 11, the men engaged in ballasting the line over the viaduct discovered symptoms of the middle arch, which crosses the turnpike-road, having given way. Workmen were immediately employed in placing timber to support the arch. It was found to have sunk a foot or 18 inches, and will have to be taken down and rebuilt. This arch was of wider span than the others, and was the only elliptic arch in the viaduct. Some persons foolishly ascribe its subsidence to its being built in that form, but it is more probably owing to the continued wet weather, as another of the arches has since been found to be cracked. They will both have to be taken down and rebuilt. This line was to have been opened in May, but in consequence of this untoward event the opening must be deferred.

SETTING OUT CUTTINGS AND EMBANKMENTS.

Sir—Permit me through your columns to submit the following simple formulæ, for the solution of a most important problem in field engineering, viz., the correct determination of the half widths of cuttings and embankments in sidelong ground. While the methods usually adopted are for the most part tedious, and all, I believe, merely approximative, the following will be found to possess not only the great advantage of facility in practice, but the result is obtained by a very simple calculation which may be made in the field.

I need hardly allude, more especially at the present time, to the practical importance of this problem, since upon a correct staking out of the half widths, not only the quantity of land required but the amount of the work to be executed is mainly dependent; an error, either in excess or the contrary, being equally objectionable—perhaps even more so in the latter case, since an extra quantity of land would be required, under probably less favourable circumstances, for purchase, and the additional increase to the slopes, subsequent to the first formation, would be attended with an increased cost in the labour.

If, in the accompanying diagram of the cross section of a cutting in sidelong ground, B′ C E represents the ground surface, H C the depth of the cutting at the centre point, corresponding to the same point on the lon-



gitudinal section, H F and H G the half-widths at the formation level, it is obvious that the simple addition of each slope (calculated to the depth at the centre) to the half-widths at the bottom would, in the present case, be inapplicable—since the widths so obtained would be too small for the upper side and too much for the lower, and the contrary for embankments.

The method now proposed is simply this:—measure off from the centre stake the half-widths, supposing the ground to be horizontal, and between the centre stake and each of the points so obtained, E and E′, take the difference of level, viz., D E and D′ E′; then the distance H C, or the true position B of the side stake, indicating the superior edge of the slope on the lower side, is equal to $\frac{CD^2}{CD + DE \times r}$ (1.)

where r represents the ratio of the slope, or of the horizontal to the vertical distance. In other words, it is equal to the square of the half width *on level ground*, divided by the sum of the same half-width and the product of the difference of level before observed and the ratio of the slope.

The distance C A′, or the position B′ of the stake on the upper side, is equal to $\frac{C'D^2}{CD' - D'E' \times r}$ (2.)

that is, equal to the square of the half-width on level ground, divided by the difference between the same half-width and the product of the difference of level, before determined, and the ratio of slope.

Thus, for example, in the diagram, if the depth of the cutting H C be 20 feet, the half-widths H F, H G = 15 feet, and the ratio of the slopes 1½ to 1, it is evident that the half-widths C D′, C D on level ground would be 45 feet:—Let D′ E′, D E (the difference of level between the above points and the centre) be respectively 8 feet and 40 feet. Then, by formula No. 1, C A the half width on the lower side $= \frac{CD^2}{CD + DE \times r} = 19{\cdot}2$ feet. And the half-width C A′ (by formula No 2), the half-width on upper side $= \frac{CD'^2}{C'D' - D'E' \times r} = 61{\cdot}3$ feet.

For embankments, the values for the upper and lower sides would be exchanged, which is evident by reversing the figure:—

Demonstration.—Draw A B, D E, B′ A′, and E′ D′, perpendicular to the horizontal A′ C D.

$$\text{Then let } AC \text{ or } A'C = x$$
$$CD \text{ or } CD' = a$$
$$DE \text{ or } D'E' = d$$
$$AD \text{ and } A'D' = a - x \text{ and } x - a$$
$$AB \text{ and } A'B' = \frac{a-x}{r} \text{ and } \frac{x-a}{r}$$

Where r represents the ratio of the slopes,

Then by similar triangles—

$$AC : AB :: CD : DE; \text{ or, } x : \frac{a-x}{r} :: a : d$$

$$dx = \frac{a^2 - ax}{r} \text{ and } drx + ax = a^2 \therefore x = \frac{a^2}{a + dr} = CA. \quad (1.)$$

In the same manner for the upper side—

$$AA'C' : D\ E' :: A'B' : D'E' \text{ or, } x : a :: \frac{x-a}{r} : d$$

$$dx = \frac{ax - a^2}{r} \text{ and } ax - drx = a^2 \therefore x = \frac{a^2}{a - dr} = CA'. \quad (2.)$$

Q. E. D.

It is scarcely necessary to mention that the above formulæ presuppose that the points C, B, E, and C B′ E′ fall on the surface, and are respectively reducible to one plane, which in fact, unless in very extreme cases, may be assumed without leading to material error in the result—at all events, the correction would be so slight that it might be made by the eye; taking the distances C A, C A′ rather in excess when the point B falls within the surface, and the contrary when it falls without.

G. Hawkins.

BROAD AND NARROW GAUGE.

Sir—I have not a single share in a railway, broad or narrow, and, in a pecuniary point of view, care not one iota which way the Gauge Question may be settled; but, for the last sixteen years, I have watched, with the greatest interest, the progress of railway locomotion, and at every increase in the capabilities of the locomotive engine I have rejoiced, as every man ought to do who purely desires the advance of art and science. From recent experiments and from daily experience it appears the engines on the narrow gauge have attained their limit as regards power, while the broad gauge engines are susceptible of an increase of power to any extent compatible with safe velocities. The engines on the Great Western Railway have not varied in their dimensions almost from the opening of the line,—having a boiler remarkably short in proportion to the other parts of the engine; but there is now building, at Swindon, an engine, the boiler of which will be of a length corresponding to the long boilers on the narrow gauge lines; the driving wheels will be 8 feet in diameter, and the calculated average velocity with an ordinary train will be 70 miles an hour. We are told that narrow gauge engines are not safe at velocities exceeding 45 miles. What an exceedingly humiliating reflection that, probably, the whole of the kingdom will be tied down for ever to a velocity of 45 miles. What is to be done? Cannot our great engineers and scientific men rescue us from this unhappy fix?—There is but one hope left for the narrow gauge, and that is, the success of the atmospheric system; but most provokingly, it so happens, that the opponents of the broad gauge are also the enemies of the atmospheric system, and Mr. Stephenson, instead of holding his post as *driver* of railway science, by the force of circumstances finds himself in the unenviable position of its *breaksman*. It is most devoutly to be wished, for the honour of the narrow gauge, that the engineers and scientific gentlemen who are most unmercifully attacking the unfortunate atmospheric system month after month in your valuable journal, would cease their enmity, and, contrariwise, take the almost prostrate system, try what they can make of it, and adopt it as a bantling of their own.

I remain, Sir,

Your obedient servant,

April 12th, 1846. S. T.

ON THE MODIFICATION AND ADAPTATION OF THE ORDERS OF THE GREEKS BY THE ROMANS AND MODERNS.

By H. Fulton, M.D.

"All nations in the most advanced state of civilisation have been unanimous in their admiration of Grecian architecture."—The Earl of Aberdeen.

The learned are agreed and we must agree with them, that the Greeks derived their knowledge of architecture from Egypt, and its neighbouring nations. We find them possessing three orders, all of great beauty; and although these orders differ from each other in many respects, yet, in the opinion of all architects both ancient and modern, they may be resolved into one elementary order—the Doric, which, there is every reason to believe, was the original one. In the ruins of the temple of Amada, in Nubia, we have a very near approach to the Greek example of the Doric columns of the temple at Corinth, the earliest known example of the order in a Greek dress: indeed, it requires but little addition to make the Nubian column an example of the Doric order, from which it does not differ so much as the latter does from either the Ionic or Corinthian. Denon, in his delineations of Egypt, gives a column composed merely of a fluted shaft supporting a low architrave; this shaft is precisely similar to those at Pæstum and Agrigentum. But this inquiry, however interesting in itself, strictly forms no part of our subject; we shall therefore dismiss it by adding, that what the Greeks did we may also accomplish, and find in the rich and almost unexplored field of Egyptian architecture many examples of detail—particularly capitals—which are capable of being Grecianised and adopted into modern practice; an example of which is given, under the name of the Victorine order, in the *Civil Engineer and Architect's Journal* for the year 1845, and is proposed as a substitute for the Roman Doric, which intention it seems calculated to fulfil.

The Greeks then had only three orders, and the Romans in making the addition of two others, effected it, as regards one, by stripping the Doric of all its embellishments, altering its proportions, and supplying a base for the formation of what is called the Tuscan. And the Composite can only be considered as a variety of the Corinthian, or a combination of it and the Ionic, and is not entitled to be received as a distinct order; nor should either the Tuscan or Composite be considered in our elementary works except as mere modifications of the other orders.

That the Romans felt the force and power of the Greek style is readily proved by its extensive adoption throughout their empire, but that they were not able to foster the adopted child with the care and affection of its natural parent, is manifest from the deterioration it suffered in their hands. The taste for, and knowledge of the fine arts amongst the Romans at the time of the conquest of Greece were at a low ebb; that warlike people came, and saw, and admired, but did not acquire a true knowledge of the grand and leading principles of the art as practised by the Greeks, either in painting or sculpture, and still less in architecture. Wealth poured its tributary streams into the lap of all-conquering Rome; everything that riches could purchase was at their command; and magnificent structures were soon raised on the spot where formerly stood the rude hut of Romulus; and so great was the change effected, even in the lifetime of an individual, that, as Suetonius relates, Augustus found the city built of brick, and left it of marble. The most distant conquered provinces felt the genial influence of the newly-acquired taste, as the many ruins still existing in Africa and trans-alpine Gaul attest. Gold has a magnetic power to attract, though perhaps not to create, genius; but the possession of wealth does not always improve the taste, and although we see in the ruins of Possidonia what Greek artists could do in a foreign land when left untrammelled, yet under the influence of Roman patronage they were not altogether so successful. It may have been observed that ignorant persons, on being shown sketches of the three orders, invariably prefer the most ornate; such a preference would also be given by a semi-barbarous people: but those who love all the three cannot censure any for preferring Aglaia, to Thalia and Euphrosyne—nay, we rather rejoice that they should be found to join with us in admiring even one of our beloved Graces, although we may be persuaded that to love one well, we must love all three. But the Romans went further than a mere preference, and rejected the claims of the elder sister; for their modification of the Doric is even worse than a total rejection. Unable to appreciate the grand—the sublime effect produced by this order, when exhibited on the scale and constructed on the principles to which the Greeks trusted for producing effect, they apparently cast this order aside; in the first instance, leaving it for homely practise perhaps; then its new patrons finding it, when deprived of all embellishments, the least expensive, and, therefore, when magnificence was not requisite, the best adapted for their purpose, may have turned it into the order now called Tuscan, as spoken of by Vitruvius; and although subsequently, in such erections as the temple of Hercules at Cori, we see that some vague idea of its former state may have been entertained, yet in Roman hands, neither ancient nor modern, has it up to the present day been treated as if its real beauty were either felt or understood; for the thing which the Romans have left us, and the modern restorers of the Greek style have served up to us as the Doric, is no more like the noble order whose name it bears, than Alexander the coppersmith was to Alexander the Great.

Nor did the other orders altogether escape modification, as for instance the capital of the Ionic, which, instead of presenting, as in the Greek, two faces and two sides, is made, by the angular arrangement of the volutes, to give four faces precisely similar. There is also a very striking difference between the flowing lines of the Greek and the spiral formation of the volutes of the Roman Ionic. Our knowledge of the Greek Corinthian is very scanty, but we may, at least, hope its capital, in the best of the Roman examples, has in some measure escaped unscathed, although in various other matters, such as the contour of the mouldings, the stylobate, and the cornice, extensive alterations were made, both in the voluted and foliated orders.

Some person has called the Tuscan the modified or emasculated Doric; this idea must be grounded on the notion of Vitruvius, who likens the Doric to a man robust and well-proportioned, for take away this character from him or it, and you take away the virility—that is, according to Johnson, the physical character—of a man. The strength or character of an order depends on the proportion of its intercolumniation and height of the shaft to the diameter of the column itself. Now the Tuscan, as given by Palladio, has an intercolumniation from centre to centre of five diameters and an elevation of seven, and, according to the same author, the Doric has an intercolumniation of nearly four and "an elevation of eight or seven and a half at least." Viola and Vignola give the same elevation, and Scamozzi eight and a half, and the same intercolumniation as Palladio, whilst the Athenian Doric has an intercolumniation from axis to axis of little more than two diameters, and an elevation of about five and a half. The ancient harridan, in modern times, finding that the blush of early beauty has deserted her cheek, and that time has bleached her scanty locks, seeks with pigments to give a colour to the one, and supplies the place of the other with the stolen ringlets of youth: but do such dire expedients as the application of paint or *the rape of the lock* deceive any one save herself? So it was also with Palladio and the rest when, with Vitruvius for their guide, they took the attenuated Tuscan and proceeded to dress it up in the Doric garb, giving the shaft a kind of colour (as it were) by fluting, and hanging a profusion of ringlets, *i. e.*, triglyphs on the brow, the frieze of the order.

It is, however, to the credit of the ancient Romans that this modified order, even when dressed in the manly garb, found little favour with them; consequently, we have but few remains of it—some amphitheatres, the theatre of Marcellus, and the temple at Cori, being the only ones handed down to us. Of the deterioration of the other orders, on which the Romans appear to have bestowed their patronage, our proofs are not so strong: they were the orders which the Greeks, for the most part, used in cases were magnitude—so essential to the full development of the Doric—was not required; hence examples of them were more likely to suffer from the hand of time, and to offer to barbarians *and others* more portable materials for the erection of their own temples and domiciles; besides, in the age of darkness and ignorance, when Grecian art was as it were eclipsed, men would naturally view the vast remains of former times (the use of which, as well as the means by which they were or could be erected, were totally unknown to them,) as invested with something of a superstitious character—the works of genii or giants, who, although unseen, had still the power to avenge their overthrow; to this may we not, in some measure, be indebted for those precious remains of the Doric order still existing in Greece and elsewhere, and to the absence of its protection ascribe the paucity of examples of the other orders in the same localities?

It has been stated by an accomplished writer on architecture, Mr. Hosking, that if two persons, acquainted with the Doric order, were desired each to give a design of a Greek temple of any specified class (the dimensions of a single column and the proportion the entablature should bear to it being given), the designs would be exactly similar in size, arrangement, features, and general proportions. Such is the stringent nature of the Greek Doric, in which respect it is unique. The triglyphs, when given, are the index of this proportion, and, except over the columns at the angles, we find one over the axis of each: at the angles of the edifice the column is placed so near to its proximate, that a line let fall from the outer edge of the triglyph will touch the circumferential line of the column at its base, thus giving increased strength to the structure. Stuart makes the measurement of the columns at the angles of the Parthenon 6′ 3″ 5‴, and those between them 6′ 1″ 8‴, and the intercolumniations 5′ 8″ 8‴ and 7′ 11″ 5‴. But the restorers have modified this either by giving half a metope outside the triglyph at the angle, or by showing a disregard to any rule, as we see in the portico of the University Club, in Suffolk-street, London. In such cases as the last-mentioned, would it not be in better taste to omit the triglyphs altogether (as we find they are in the pronaos of the Greek examples), and substitute sculpture in their stead. We stated that it was the rule to have only one triglyph between those over the axis of each column; there is, however, an exception of high authority, as may be seen in the Propylea,—but it forms the exception, not the rule; and although this structure is very beautiful in other respects, yet did we not know that it was erected in the age of Pericles, when art was in its zenith, we should, on account of this deviation from the general rule, have ascribed it to a period subsequent to the Roman conquest. It would appear that the reason of this wide intercolumniation between the centre columns of the Propylea was, that a larger space might be left for the passage of equestrian processions to the Acropolis. If we were constrained to assume the functions of the judgment-seat when the example was pleaded as a precedent, our decision should, in legal phraseology, be, "*Like case only like rule.*" But let us not forget that although we may pay the closest attention to all the minutiæ of the Greek models, yet a repetition of the Doric in small cannot be effective, for MAGNITUDE IS INDISPENSABLE.

Although the Romans proved by conquest that they were superior to the Greeks in arms, yet they were inferior in arts, and for a time had recourse to the importation of Greek artists, and, in the reign of Domitian, columns were taken from an edifice in Greece for the purpose of rebuilding the Capitol; but such was the taste of the Roman architects, that they were altered under the pretence of being polished, and, as Plutarch, who saw them previously in Greece, says, "they gained not so much in the polish as they lost in proportion, for their beauty is injured by their appearing too slender for their height." In the old church of Araceli, on the Capitoline hill, which contains many antique columns, there are some, not difficult to imagine as being the identical ones alluded to by Plutarch. But the wholesome stimulus of good taste in the employer could not be imported as early as the artists themselves, and it is in the nature of the mind not to produce beyond what is required of it. Who will be at the pains of cultivating a flower that must be

"————born to blush unseen,
And waste its sweetness on the desert air?"

It may be replied to this that the ancients, both Greeks and Romans, put the highest degree of finish on parts that never could come under observation as long as the buildings stood—but not so; for superstition invested their gods with the power of visiting their temples, and hence every part which might possibly come under their scrutiny was made as perfect as possible. Another cause for the modification of the transplanted architecture was the scarcity of materials of sufficient magnitude to construct buildings with on the Greek models: if, under such circumstances, Greek employers had been substituted for Roman, and Rome had become a Greek colony, then, indeed, there can be no doubt that all the modifications which materials rendered necessary, would have been guided alone by those principles which had sustained the character of Grecian architecture as the first in the world—superior to the Egyptian in this respect, that whilst, with less bulky materials, it preserved the character of grandeur, magnificence, and simplicity of outline, it imposed thereon an elegance and harmony of detail, which made it rise superior to its prototype. But no such fostering influence met it on the banks of the Tiber: the ancient Romans, like some moderns, had indeed a great desire—a longing after magnificence, without being aware of what its constituents were;—possessing the superiority of conquerors, they were too ignorant—too vain, to learn, or rather submit, to the taste of the vanquished, whose productions they condescended to appropriate in order to grace a triumph and mark a conquest; and although we see in the earlier works of Italy many vestiges of the good taste of their instructors, yet a history of its progress under Roman patronage would be a narrative of its decline and fall, for other principles guided them subsequently, and they in vain sought to give their edifices that grandeur, which the Greeks had been able to effect by a far different method. The art appears to have run riot in Roman hands, if we are to ascribe to them the erection of Baalbec and Palmyra, entire cities built on a scale of magnificence and splendour which would not be credited were the fact not attested by their existing ruins; yet these ruins, extensive as they are, possess no feature worthy of our imitation, except it be a few details of mouldings which have been introduced into the interiors of our domestic edifices.

The principles of the one school were sure and fixed, and incapable of being perverted, whilst those of the other were unstable, and led to every possible variety, until they brought ruin on the art, and so early as the times of Diocletian, obliterated almost every vestige of its origin. In succeeding ages, which we call dark, architecture lay buried under its own ruins: but the most sanguine enthusiast could scarcely have anticipated that out of this chaos a new style should have been created, having claims on the admiration of posterity; and that, in the hands of men who have left no written or other record of their knowledge of science or art, the examples of the florid Gothic of the middle ages should have been brought to that state of perfection which we cannot surpass; this, however, forms no part of our present enquiry. Subsequent to this period, there arose in Italy another set of men, who did not aim, like the Freemasons, to create a new style, but professed, by the aid of the works of Vitruvius, to resuscitate the ancient one out of the incongruous materials by which they found themselves surrounded. If, instead of doing this, they had consigned Vitruvius to oblivion, and followed the example of the Freemasons, they might have given us something good—at all events, they could not have given us anything worse than the so-called revival. Greek models they did not seek for, but even if it had been otherwise in this respect, we have no reason to suppose that the purer specimens would have found more favour in their eyes, than the best of the Roman did. Serlio and Palladio drew and published almost all the Roman examples existing in their day, yet, in their own designs, show how little they studied the best of them, except to copy a capital or a cornice.

The restorers who flourished principally in the fifteenth century are called for the sake of brevity, the Cinque-cento school; they were all of the same country as the earlier debasers of Grecian art: eminently successful in painting and sculpture, the Italians fell far short indeed in architecture. Unacquainted with the Greek models they yet set about the restoration of the style; their country never possessed any example of the pointed Gothic worthy of attention, and indeed the very name *Tedesca* impinges harshly on an Italian ear, and the mere suspicion that Germania was the country of its birth was sufficient to create a prejudice in the mind of an Italian patriot; so it was altogether passed over without notice, and our own Jones and Wren, not finding any mention made of it by any of the admired authors of the Cinque-cento school, at once stigmatised it as barbarian; but it is remarkable that in proportion as the beauty of the pure Grecian is known and felt, so is that of the Gothic appreciated; and so it ever will be in art, a correct taste in one branch leading to the due estimation of others.

It is true that the change of habits and the difference of climate may, in many respects, render what was once appropriate not fitting now, and it must also be admitted that all the examples of Greek architecture which we have, are either of the templar or monumental description, and therefore may not be suited for domestic edifices. We know from the somewhat Greek town of Pompeii, that a great difference existed during the first century in the style of domestic edifices, and no attempt was made to render the former similar to the latter, but, on the contrary, it was at one period unlawful to make the attempt in Rome, and not customary in Greece; for Julius Cæsar obtained permission by a decree of the Senate to make the front of his house like a temple, and Demosthenes, about a century after the death of Pericles, directed the thunder of his eloquence against the practise as an innovation. Columns, both square and cylindrical, were however much used for internal decoration and construction in Roman houses, but the exteriors were plain, and for the most part, devoid of all architectural ornament: according to Vitruvius, the exteriors of the town houses were quite plain, all ornament being reserved for the interior; just as we see at Pompeii, and as is the custom in the towns of China at the present day. However, in the so-called revival of Greek architecture, any building, although its outline might be broken up by receding or advancing wings—although it might have a pediment in mockery only of a gable, or not extending the entire length of the façade—although it might have its frieze pulvinated, its stylobate not graduated, its intercolumniations extended, its columns (some of them sinecure) of different orders—

attenuated, unfluted, coupled, and mounted on stilts: its antæ fluted, diminished, and capped, as cylindrical columns should be; its cornice crowned with an attic, or perhaps a balustrade; its shallow portico a mere afterthought, advanced in front, and thus made the only prominent feature in the composition; instead (as the painters would say) of every part being worked into each other, so as to produce one whole;—or, in short, although it might have all the characteristics of the cinque-cento school, provided that in some respects it bore the resemblance of a caricature to the original, it was designated as a Greek composition.

In this so-called revival, abundant use is made of columns, particularly as dressings for windows and doors; and here there is a marked departure from the principles as practised by the ancients and even as laid down by the restorers themselves, namely, that the intercolumniation should not exceed a certain width. Palladio, in the 13th chapter of his first book, says that "the intercolumniations of the ancients never exceeded three diameters except in the Tuscan." Now if only three diameters, or four from centre to centre, be given, the opening would be too narrow either for a door or a window; hence the use of them in such situations in practice is contrary to the principles so peremptorily laid down in theory. The great object to be attained in the use of columns is the depth of shadow, which has been called the *chiaro-scuro* of architectural composition, but as window dressings are stilted on a lofty stylobate they degenerate into mere *quasi* ornaments, affording no shadow that can be seen. The practice of wide intercolumniations in order to admit a window or door is defended on the ground of the columns being attached, and therefore not requiring to be limited in the interspaces; but this seems like doing a thing in the first instance, and finding out an excuse for it afterwards; and there appears to be no good reason for placing them in such situations, as they then convey no idea of utility, and a wide intercolumniation and lofty situation prevent their being ornamental; besides, attached columns are only to be defended on the ground of their harmonising with those that are insulated, and this they do not when placed as door or window dressings; but it can scarcely be said that when so placed they are *attached* in the usual acceptation of the term, for the architrave, or whatever may supply the place of one, has not the aid of any other support.

For the practice of coupling columns, an expedient by which the simplicity of the composition is marred, without any commensurate advantage being obtained, we are said to be indebted to him who was justly called the Prince of Painters.

We must not omit mention of the practice of adapting single columns for monumental purposes. The first example we have of this is the Alexandrine column, called Pompey's pillar; then the column of Phocas at Rome; these are both of the Corinthian order. Of an earlier date than the latter, we have modifications of the Doric in those of Trajan and Antoninus; and in our own times, a copy of Trajan's in the Napoleon at Paris. In England we have several of both orders, but we are not aware of any in the Ionic. The legitimate practice of architecture rejects a column in the singular number, except as a fractional part of an edifice, and always requires, in the horizontal styles, that it should be surmounted by a suitable entablature, in order to give it that completeness which the eye seeks for from association—the architect's line of beauty, from which he is slow to admit of any deviation. Although, by their sculptured reliefs, the columns of Trajan, Antoninus, and Napoleon, are in a great measure taken out of the class of edificial columns, yet they, as well as those not so circumstanced, are unsuited for the reception of figures on the summit; for if the figure be badly designed and executed it should not have place anywhere, and if well designed and executed it is lost to the eye by its exaggerated elevation. An Irish round tower or an Egyptian obelisk offers a more appropriate model for a monument or landmark than any modification of the classical orders.*

In a Greek composition the columns may be said to form the building itself (supporting its entablature, on which the roof is imposed); not ranged in broken lines, for the purpose of pictorial effect, but presenting an integrity of outline—giving the idea of completeness and unity of one whole, and not several parts badly suited in size and form to be joined together; for, as an accomplished writer has said, "however startling it may be in geometry, it is true in taste that a great many little things do not make a great one." It has been justly said that all the parts of a Greek composition which are useful or necessary are rendered pleasing, and what is beautiful appears to be necessary. The aspect of a building of this description will be a bold unbroken outline; the ornamental parts from a distance, will appear subdued, so as not to interfere with the appearance of unity, and merely solicit a closer examination; and when, to obtain this, the eye approaches, the most highly finished details alone lay claim to inspection,—fitness, completeness, and harmony, will be the distinguishing characteristics throughout the entire. Let us bring some of the edifices erected in the so-called revived style to this test, and the difference in the effect produced shall at once be evident. If then our most elaborate and expensive compositions fail in this, should we not inquire how the defect might be remedied? Perhaps it may be urged that grandeur, magnificence, sublimity, and harmony, have all been attained in the florid Gothic; but it must be considered that although in detail this style is trifling, weak, and often ridiculous, yet the parts in themselves are so minute, and the outline so bold, as rather to afford a proof of the contrary. There was a man who dared to work out the Greek principle, and that man was Michael Angelo Buonarroti—a name that stands second to none either as painter or sculptor,—a name which it is difficult to decide as meriting more praise or censure as an architect. In the noble cornice of the Farnese palace, and the daring dome of St. Peter's fane, we have the principle carried out on another model; the remainder of the Farnese palace was designed by San Gallo, and cannot be laid to the charge of Michael Angelo.* But if, after seeing the dome of St. Peter's, we cross the Tiber, and look at the Capitol, we find it hard to believe that it is the production of the same hand, and would willingly ascribe it to some other San Gallo did truth permit. The beauty of the dome almost covers all the architectural sins of the rest of the edifice, but the Capitol presents no such redeeming feature; all is trifling and unworthy of the name and site, and fit only for the habitation of the feathered guardians of the mount—whose effigies in bronze it contains,—but not to crown a ROMAN FORUM even in ruins!

It must at the same time be mentioned, to the credit of Buonarroti, that his plan was to make St. Peter's in the form of a Greek instead of a Latin cross: with the former figure the dome would have been more effective exteriorly, and on this account it is to be lamented that a sectarian feeling of preference for the abstract figure subsequently prevailed over the better taste of the architect. We participate with Sir Joshua Reynolds in the admiration he expresses for "this truly great man," and gladly turn from his faults to admire his excellencies, and see in the dome and cornicione the efforts of genius emancipating itself from the trammels and false principles of a vicious school. He also intended to have given a portico to St. Peter's on the plan of that of the Pantheon of Agrippa, instead of Carlo Maderno's miserable façade; such a portico, with a colonnade of the same order, on the plan of the present one, but having its entablature and stylobate on a level with those of the portico, would indeed have exhibited what the art was capable of effecting, and given a *coup d'œil* superior perhaps to anything in art the world has ever yet beheld. The genius and taste which designed such examples as the dome and cornicione are exactly what we most require in modern times; not, indeed, for the production of isolated features to redeem a composition from censure, but as parts only of works in which the same character shall be carried throughout the entire.

Much has been written by accomplished authors on the subject of taste, and rules have been laid down for the formation and direction of it. In an altogether artificial art like architecture—a mere creation of the mind—we can glean but little from nature for our guidance, and are driven to refer to the best models of each particular style to form our rules from what we there observe; and it would be wise to take it for granted as a general rule, that those who had the genius to invent a style or sub-division of one, were the fittest persons to give rules for the guidance of those who were to follow them as copyists; therefore it would, in most cases, be more desirable to invent a new style for our purpose in preference to violating the rules observed in the old ones, or applying their peculiar and striking details to other purposes than those for which we find them invented. The architect who does so may indeed lay claim to a kind of invention, but it is of the lowest description, and is anything but a proof of genius. Had we known nothing of Greek architecture save what we see in its restoration, doubtless we should have thought these restorations very beautiful, and have been perfectly satisfied to have formed our tastes on such models; but a single glance at a Greek peripteral temple would awaken in us new sensations of pleasure, and leave an impression that would never afterwards be obliterated from the mind. Seldom do our climate and wants admit of the erection of such a structure, but happy indeed must be the lot of the architect to whom such an occasion shall fall of offering that, the

* See a paper on Obelisks in the "Civil Engineer and Architect's Journal," Vol. VIII. 1845.

* The details of the dome do not deserve commendation.

sight of which is pre-eminently calculated to form the taste both of the public and the profession.

It was unfortunate that architecture, at the period of the revival of the Greek style, was taken up as a profession by painters, whose minds are too much imbued with a love of the picturesque ever to admit of their producing a good effect with such materials as wood and stone. The carpenter's plane and the mason's chisel completely remove all that gives picturesque effect to the tree and the rock; and the painter seeks, by the arrangement of the principal parts of an architectural composition, to produce what a skilful architect will effect by the minor details, namely, a variation of light and shade—not as the principal feature of his picture, but merely as a tinting; to obtain which he has not sacrificed either unity or simplicity. It matters not then to the painter-architect whether his columns be fluted or not; all he cares for is to avoid what is not his line of beauty—a straight one, which happens to be the very main-spring of beauty in a Greek composition. The generality of mankind are better informed on the subject of painting and are better judges of it than of architecture; hence, so many side with the painters, and architects are driven to succumb to the ruling taste of the day, and to fashion their designs, not with reference to how they must appear in the solid, but to how they do appear as pretty pictures on paper. It will not avail anything to argue this with the painters, for—

"Convince a painter against his will,
And he'll hold the same opinion still."

Nor still less can it avail to argue with those who are led by the opinions of the painters, and such are the great mass of those who compose what are called Committees of Selection, who must be treated as children—as babes in knowledge; and, instead of giving them a toy, which they would in a state of innocence seize with avidity and soon after as capriciously throw aside, something that they would prefer and continue to estimate when their judgments shall be more matured and their taste improved should be given. It is generally admitted that the Propylea at the London terminus of the Birmingham Railway is one of the best examples in this country of the Greek style, and justly, one of the most admired; yet we should tremble for its fate if its geometrical elevation were to be exhibited before a Committee of Selection in competition with one of the façade of the Goldsmith's Hall, the production of the same architect: in short, the latter would appear on paper, to the eye of a committtee-man, as much preferable to the former, as it does in stone to the eye of every one. An architect of genius will reject the opinions of such tribunals. Let committees say what they require, and provide the funds—that is their legitimate portion of the division of labour. Would any of the great painters (to whom their art is so much indebted for a true revival) have submitted to the control of ignorant monks (who were their best patrons) in handling their works? Did Titian alter his style because these monks objected to his figures appearing to stand out from the canvas? And shall architects be less free from the intermeddling of ignorant pretenders? It is greatly to be feared that too many in the profession are fettered by the opinions and taste of persons who neither know, nor even profess to know anything about the art—a state of things which it is neither the interest of the public nor the profession should be maintained.

In reviewing the modifications which the style experienced in the hands of the Romans, one of the most important is to be found in the arrangement of the portico, which, in all the edifices remaining in Greece, Magna Grecia, and Sicily, with the exception of the two porches attached to the little octagonal tower of Andronicus Cyrrhestes, called the Temple of the Winds, forms an integral part of the design, from which it is impossible to consider it separately. The earliest example we have of the Roman modification is that of the Pantheon of Agrippa. This magnificent portico, raised on a graduated stylobate of nine steps, has eight columns in front, and, reckoning those at the angles, three and an antæ at each side; if the columns were fluted, and the antæ not, and these latter had suitable mouldings instead of foliated capitals, this portico would perhaps possess all the excellence that taste could require or fancy conceive. The necessity for an isolated portico in that instance is obvious both from the form and magnitude of the principal building, which, for the latter reason, at once forbids the attempt to make the cornice of the one correspond in line with that of the other. The unornamented state of the Great Rotunda also suggests that probably it either was, or was intended to be, concealed from observation by surrounding buildings, leaving only the stately portico itself in view; however this be, the idea of what may be either called an attached or a detached portico seems to have been seized with avidity in modern practice, where it is made not an ornamented part of the design, but rather a mere ornament attached to it. In many instances the difficulties arising from considerations of expense seem to be more powerful than good taste in influencing the selection of a starved-looking portico of four columns only in front, instead of six or eight or more, which would have occupied the entire field; and for the same pecuniary reasons, the rear ranks of columns, which, by the depth of shade they afford, are so essential to the beauty of a portico, too often are dispensed with. In the instance of the nine column portico at Pæstum, we see how indispensable the Greeks considered it to be that the integrity and unity of outline should be preserved. In more modern practice, a building of this description would probably have been furnished with only four or six columns in front, leaving the angles of the exterior of the cella either naked or with a pilaster; thus making the cornice of the portico and that of the rest of the building on different ranges. One of the most beautiful, as well as one of the most perfectly preserved examples of Roman taste we have is the little pseudo-peripteral temple at Nismes, called the Maison Carrée! If, with a transposable model, we take away the flanking columns of the portico, or attempt any other arrangement of them, unless it be to make it peripteral, it will be seen how much it may be deteriorated in effect: but it seems unnecessary to enter into a lengthened condemnation of a modification which no one attempts to defend on the score of good taste, though many practice it on the plea of saving expense, as it must be their poverty and not their will which consents.

Another departure in most of the Roman examples, from the plan of the Greek portico is the larger space left between the two centre columns. In the Ionic and Corinthian orders if not carried to excess, this is scarcely perceptible, but in the Doric it necessarily requires an additional triglyph, and is highly offensive and painful to the eye, as the architrave is elongated, and of course apparently weakened at the place where it has to sustain the loftiest and weightiest portion of the pediment; for although in building (using the term in contradistinction to architecture), it may answer every purpose if the supporting parts be sufficiently strong to bear the imposed burden, yet in the higher branch which commends itself less to the judgment than to the eye, that organ must be satisfied both from analogy and comparison: for instance, the inclining tower at Pisa was erected, and acquired its present inclination of about twelve feet from the perpendicular about 670 years ago, and although the spectator may be assured from the experience of so many centuries that it may remain some years longer, yet after the first effects of astonishment subside, it is a painful object, between which and the eye it is impossible to effect a reconciliation.

It was the practice of the Greeks to make the base of the triangular pediment correspond in length with the cornice on which it was imposed, just as we see a capital correspond in diameter with the neck of the shaft which it crowns; but it is now the practice either from poverty of taste or of purse, or both, to place on the cornice a pediment with a shorter base; it would not be more at variance with good taste were we to suggest that for the sake of harmony the capital also should have a less diameter than the shaft; and again, the pediment was the crowning feature of the composition, and had no wall, attic, or parapet either pierced or unpierced above it, but just as the capital was placed on the summit of the shaft; modern practice in the management of pediments is frequently otherwise, and we might with propriety propose that when it is deemed advisable to surmount the pediment with a mass of building, the columns also should have their elevation increased by the addition of a portion of shaft placed above the capital,* but if any object to this suggestion, then we have only to reply that our proposal is as capable of defence as their practice, and we are willing to let both fall together. We are confident that Mr. Hay will agree with us on the justness of the hypothesis, and from his admirable works on the harmony of colour, form, and proportion, we could not appeal to a more able judge.

The rage for pediments appears to have commenced in the reign of Diocletian; not satisfied with one at the gable ends of each edifice, the exaggerated taste of that day required that they should be represented in small, and turned into dressings for doors and niches; the latter in some measure corresponding with our windows, thus making a kind of mock-gable where no real one could possibly have place. Such a description of window dressing, although more expensive than appropriate mouldings, is very fashionable in our own times, and was also much used by the cinque-cento restorers.

The discovery, or as we should rather say, general introduction of win-

* We do not lay any claim to originality in offering this suggestion, for we have in our possession a much admired columnar chimney piece of cinque-cento design, from which we take the hint.

dow glass, causes a great difficulty in the arrangement of the Greek templar edifices. That the Romans were aware of this use of glass is evident from the discovery of it at Pompeii, as noticed in the second series of Sir William Gell's work, but they appear to have availed themselves of it so seldom that for a long time it was thought they were not acquainted with it. The little use made of it by them is to be accounted for, partly from the bad quality of their glass, and partly because their plans of buildings were matured before the invention was known; and their in-door worship did not require that the light of day should be admitted into their temples. It is quite idle now to dilate on the disadvantages of introducing windows into Greek compositions; the necessity for them is paramount, and all that remains for us to do is to render them as little discordant as we can; nor are we without Greek and Roman models to guide us, as may be seen in the temple of Erechtheum, at Athens, and that of the Sybil at Tivoli. In both instances they are of the size and form of ordinary windows, and merely ornamented with mouldings. The inside of the jambs of those in the Erechtheum are revealed, as if for the insertion of window frames, and they were most probably filled up with thin plates of semi-transparent marble, such as those spoken of by Pliny, and found in the Parthenon by Wheeler. The Chinese sometimes use thin laminæ of the mother of pearl oyster-shell, but more generally oiled silk for the same purpose.

In the palace of Diocletian we also find the pulvinated frieze which was taken into high favour by the *Restorers*, and not yet entirely laid aside in modern practice, though otherwise left undefended from the condemnation it has met with from all authors who have written on the subject: it looks in effect as if the frieze had been made of some soft material, and had given way under the pressure of the cornice, a semblance of weakness which may harmonize with the works of the cinque-cento school, but is totally inconsistent with Greek principles of construction; indeed it is difficult to conceive on what ground it could be recommended, or to guess why, except from carelessness, any architect of ability should disgrace his composition by its introduction, as we see it in the façade of one of the most admired Club-houses in London; but as this edifice, like the Farnese palace, has also a redeeming cornice, may we not be indebted for its window pediments, pulvinated friezes and balustrades to the taste of some modern San Gallo? The pulvinated frieze was thought to be a proper accompaniment to the Roman Ionic capital, and it must be admitted that the capital is quite good enough for such a frieze.

Many and great as the modifications of the Romans were, they are chargeable with nothing so preposterous as turning the graceful column into a hideous pigmy, for such is the dwarf column or baluster of the Restorers. Florence, the Athens of Italy, is said to have been the city of its birth in the first century of the revival; that it ever could have entered into the head of an architect to invent such a thing, is somewhat difficult to believe, indeed as much so as to discover the reason of its preservation in modern practice in preference to various other forms of rails and piercings. It may be described as an unhappy little column compressed into deformity by some process analogous to that by which *gobbi* (for which Italy also is celebrated), are made; and it is often introduced into a composition into which columns of due proportion enter, doubtless in perfect consistency with some laws of harmony with which we are unacquainted.

A striking difference in the practice of the Roman and Greek schools is to be found in the formation of curved mouldings; those of the former being parts of a circle may be formed with compasses, whilst those of the latter being excentric can only be drawn by the hand, and are in fact the line of beauty of Hogarth, in whose time what are now known as Roman, were supposed on the authority of the Restorers to be Greek mouldings. For a careless architect, and an ignorant employer, the Roman forms may do well enough, but by those who have eyes to see them the Greek will be preferred.

Both schools (as far as our observations extend) appear to have agreed in all cases on the necessity for a stylobate, although they differed much as to its form; in that respect modern practice is not similar—for we have seen many porticoes without any, though none so circumstanced that would not have been improved by the addition. With the Greeks it was formed in three receding courses, proportioned to the diameter of the column; but with their imitators no rule of any kind seems to have existed, except indeed, that the ancients, when it was formed in receding courses, thought it necessary that the number of the courses should be odd, in order that the temple might be entered with the right foot in advance. It might appear without due examination, that the triple arrangement of the stylobate was in itself a matter of small importance, but those who have observed the Greek plan particularly, in the Doric order, will not be of this opinion, or admit that any other numerical arrangement could produce the same pleasing effect. The most searching scrutiny into the practice of the Greeks, not only in this but in every particular relating to the art, must end in convincing the mind that they exactly attained the point of beauty. It would appear from all the Greek examples, with the exception of the Choragic monument of Lysicrates, that columns when used externally, were intended to have the appearance of affording facility of entrance into the edifice, or to harmonize with those that did; which intention would be entirely defeated by a lofty stylobate, and in modern practice it has often too much the appearance of a penurious expedient in giving a small column instead of a large one, thus showing a starved design. Besides, when columns are placed so much above the point of sight, as they frequently are, they fail in producing the desired effect. In modern adaptation we see an unhappy expedient, if possible more fatal than that of endeavouring to gain elevation by a lofty stylobate; we allude to the practice of piling columns upon columns. It cannot be denied that the entablature ought to be in proportion to the height of the façade, and therefore the superior must have in such cases a greater projection than the inferior ones. How can any harmony, any just proportion, any simplicity be attained in such compositions?

In this adaptation, for which they are not adapted, the columns and their accessories, whether they be of the same order or not, or whatever the scholastic arrangement may be by which their order of succession is regulated, are debased, and the expedient reflects no credit on their compilers. The most remarkable instance in this country of the practice is the façade of St. Paul's. Sir C. Wren never saw either a Greek or Roman edifice, yet his first thought (and first thoughts are sometimes best), was to make it with only one range. The practice seems to have arisen with the Romans, in the construction of the amphitheatres, for the interior arrangement of some of the Greek temples can scarcely be considered as a precedent.

By far the most important modification which awaited Grecian architecture on its reaching the banks of the Tiber, was the engrafting of the arch. That the Greeks were acquainted with this valuable addition to the science of construction is not certain, for although many persons have inferred it, yet none have been able to prove the affirmative. It is certain, however, from the *corbelled* dome of the treasury or tomb at Mycene, that they were at a very remote period acquainted at least with its form, though not its principle. To the Romans has been given the credit of its invention, and they may be entitled to it, but not exclusively; for the discovery of Mr. Hoskins the traveller, in Ethiopia, sets that point at rest. At Meroë, the ancient capital of Ethiopia, he found in the porch or entrance to one of the pyramidal tombs, which he fairly supposes to be of greater antiquity than any similar structure now existing in Egypt, a regularly constructed circular headed arch, with a key stone, supported by lateral pressure. This arch consists of alternate courses of four and five stones, and when there are only the smaller number, there is no single keystone. The span of the arch is five feet. At Gebel el Birkel, near the fourth cataract of the Nile, in the interior of another pyramid, he found a pointed arch supported in the same manner, having a joint at the apex, and apparently of a later date than the former; he also found a brick arch forming the tomb of Amunolph 1st., at Thebes, and this arch was constructed exactly like those of the present day, and had a span of eight feet six inches. As this king reigned 1650 years before our era, we can at once fix its date as nearly 800 years anterior to the building of Rome.* It has been said that probably the bow which the Great Architect of the Universe has placed in the Heavens, furnished to the Romans the idea of the arch in construction, if so, they soon attempted to improve on the model, by the introduction of the dropping keystone, which destroys the similitude. Or it may have been that as mathematicians assert, the circle to be the most perfect of all figures, it was desired to refute this and "relieve the eye" from its monotony, by giving a figure with a broken outline.

But, however the Romans may have arrived at the knowledge of the arch, it soon became general, and its introduction was fated to destroy, for a time, the architecture of Greece, and raise out of its ruins another style to compete with it for a share of the admiration of mankind. Long before we find any traces of the Greek orders in Rome, we see the arch in the Cloaca Maxima, which was constructed about the year 519, before our era; after this we have it at Pompeii, and in the triumphal arches and amphitheatres of the first and second centuries, when we see a striking and fatal departure from the Grecian rule, as to the width of the intercolumnia-

* Diagrams of these three arches are given in the Civil Engineer and Architect's Journal, Vol. VII., page 181, 1840.

tion occasioned by the combination of columns and arches in those structures. When in this examination we pass on to the temple of Antoninus and Faustina, we find that Palladio gives in the restoration of this edifice court in front (not now to be traced), part of which he says he saw removed, and in this restored court we have an arcade nearly similar to what he gives as that of the Corinthian order; then at the palace of Diocletian at Spalatro, we find arches springing from columns, the germ as it were of what was afterwards to be perfected in the pointed style, and produce the clustered column and the lancet arch, which in the long drawn aisle and fretted vault exhibit the glories and triumph of monastic architecture; for however that style may be indebted for some ideas to the Saracenic, imported at the time of the Crusades, yet at Spalatro we have incontrovertible proofs of its origin, even to the grotesque human heads and the zigzag ornament we erroneously call Saxon, and suppose to be peculiar to that style. Here we have also two legs of different arches springing from one column, both with and without imposts, the columns themselves raised on consols, these latter being ornamented with grotesque heads just as they are in the Gothic. When then we hold in one hand an elevation of the Parthenon, and in the other one of the Cathedral at Cologne, however startling it may appear, the style of the latter is a modification of that of the former. Some architects have drawn rather too largely on the harmony relationship might be supposed to maintain between the two styles, and have grouped them together as we see in the Duomo at Milan, and some of the alterations at Westminster Abbey.

It must be admitted that the Moorish architecture existing in Spain is very similar as regards the support of the arch to that at Spalatro, but when we consider that all the Mediterranean coast of Africa was a Roman province, and see in it the remains of an earlier and purer state of art, we may reasonably infer that Africa was also indebted to the Romans for the introduction of the method of raising their horse-shoe arches on columns.

Of Grecian domestic edifices we absolutely know nothing, except through those of Roman taste, and we may fairly conclude that those of the former differed as much from the latter as the public edifices of the two people did: however it is in vain to speculate on this point, and we must take the Romans as we find them, in the disinterred city of Pompeii. One thing very worthy of observation in the interiors of the edifices of this place in which they differ so much from those of more modern times, is that in almost every instance the hand of the architect is seen, and not the mere monotonous arrangement of a common builder. It is very true that difference of climate and habits prevent us from taking the Pompeiian houses as models for the construction of modern domestic edifices, yet much may be learned from a study of them, and the pleasing variety of character that may be given to interiors by a judicious architectural arrangement too often overlooked by us. An inspection of the house of the late Sir John Soane will show what can be done in this way even in an edifice of ordinary size and exterior, and in this point of view, independent of the models and treasures of art which it contains, the legacy of it to the nation is a bequest that can scarcely be too highly valued. It is curious to observe the similarity in the ground plans of the domestic edifices of the Chinese and those at Pompeii; and also between the temples of the same people and those of Egypt, the details indeed have nothing in common in either case, but the plans are much more similar than anything to be found of a modern date either in Italy or Egypt, are to the ancient buildings of those countries.

Both the Elizabethan and the Italian villa style are modifications of the Greek; and it is remarkable that when once we leave the fountain head, the farther we go from the source the clearer the stream runs, *i. e.*, when the modification ceases to bear that kind of resemblance that a caricature has to the original, it presents something original in itself, and ceases to be offensive to the eye. Perhaps the great merit of these styles when used for domestic purposes consists in their pliancy and freedom from strict rules. When well designed they present pleasing compositions, but never can aim at anything higher.

The Greek style has suffered much from its professed admirers and restorers, and it has now to sustain an attack from its avowed enemies; for in our own times and country the senseless cry of no Pagan, no Heathen, is now raised against it; as if the style which the short-sighted bigots have selected to supply its place were not equally obnoxious to the charge. Do these anti-Pagans not recollect that many of the sacred writings from which they profess to draw their religion, were written in a Pagan tongue; and that to acquire a knowledge of it and enable them to teach their religion to others, they store their minds with the history of all the abominations of Paganism? Whether the Greek style be more suitable than the one they have selected for the erection of *their* temples we do not pretend to decide, but we do maintain "that things which are equal to the same are equal to one another"—and further, that the Christian dispensation was not intended to overturn any of the practices, inventions, or institutions of mankind which were not repugnant to its own laws and precepts. According to some the great temple of Jehovah at Jerusalem, was in the Egyptian style, and to others in the early Greek of Pæstum: in either case the style must have been the same as that employed in the construction of Pagan temples. The Rev. James Dallaway, in his DISCOURSES ON ARCHITECTURE, has fallen into an error in saying that "the Basilica of St. Paul's, at Rome, erected by Constantine, had the earliest instance of arches constructed on columns instead of piers," and may have led his reverend brethren (unintentionally, we believe), into the error of hence supposing that form to be of Christian invention; but they cannot continue to hold this opinion after examining Adam's View of Diocletian's palace at Spalatro.

With the exception of the form of the cross in the ground plan, the mullions of windows, the rose or wheel windows, and the spires, (important features no doubt, yet insufficient in themselves to constitute a style), we know of no other characteristic that can be said to be exclusively of Christian times or countries; for all else we are more or less indebted to the Pagan or the Moslem.

It was admitted, in a former part of this essay, that difference of climate and habits may require different descriptions of edifices, both public and private, from those that were erected by the inventors of the Greek style; but it cannot be too strenuously urged, as before stated, that if it be desired to preserve the character of a style in its purity, we must adhere strictly to the principles that guided its inventors, although, from circumstances, we may be constrained to modify the style in its application. A Greek composition is not a thing of shreds and patches, with a portico stuck on its front; nor is it a receptacle for groups of mock pediments, a retreat for a pigmy ordinance, nor yet an asylum for columns out of place. Simplicity of the most bewitching kind, an air of repose and completeness, and the most perfect harmony, pervade every part. It would be impossible to lay the finger of criticism on any ornament and say that it could be dispensed with, or its place more appropriately supplied by any other: such are the examples which the architects of the age of Pericles have left for our instruction, and when we attempt to modify them to suit our present wants, the great difficulty is to preserve their evanescent spirit; still it appears to be within the range of possibility to do so, but only by those who are thoroughly imbued with the idea that these models contain in themselves the elements of perfection sufficient for a new creation of the art if all else were lost. On that feeling the success of our adaptation depends; without it, an edifice may have a verbal resemblance to the model without possessing its expression; may be ornate, but not ornamental; convenient, but not symmetrical; well constructed, but ill designed; the work of a skilful builder who understands his trade, but not the production of an accomplished architect who aims at the highest walk in his profession; it may induce the groundlings to stare, but it may also force the judicious to grieve.

With the sublime works of the ancient masters for our guidance in the three orders we have sufficient materials to work upon, to modify, combine, and adapt for our present requirements, and the instruction of future ages. As soon as we shall have these examples, not only in distant lands and geometrical elevations, but realised before our eyes in our own country, then they must effect an improvement in our taste, and then we shall be better able to invent and make new combinations on the same unerring principles exhibited in our models; in short, we must first have a pristine—not a *cinque*—but a *novocento* revival; and it would appear that such was the opinion of the Institute of British Architects in proposing the subject of the present essay. Let us commence then by discarding, *in toto*, the emasculated Doric, and when we compose in the Doric itself let us recollect that our conceptions must be the works of giants, and not the efforts of pigmies; and in the Ionic and Corinthian, that the ornate capitals require ornamented shafts, and that sculpture adds much to the beauty of the frieze in all the orders. We must also guard against breaking up the entablature, and in the treatment of porticoes bear in remembrance that those which are wanting in depth must be deficient in beauty. Let us also remember that although windows be necessary evils, yet it is not necessary to increase the evil by incongruous ornaments; and that our designs must have unity and be one whole, not a collection of separate and distinct parts.

For ourselves, although in various countries we have seen "cloud-capp'd towers, gorgeous palaces, and solemn temples," of christian, pagan, heathen, and moslem construction, yet we remain convinced that (as has been well said) "for all the higher effects which architecture is capable of producing, a Greek peripteral temple of the Doric order is UNRIVALLED."

THE PRINCIPLES OF CHURCH RESTORATION.

Those who can distinguish between the revival of the ancient principles of pointed architecture and a mechanical imitation of ancient forms, have no difficulty in recognising the propriety of restoring the numerous ecclesiastical and civil edifices bequeathed to us by our mediæval ancestors. An important distinction between the renewed appreciation of pointed architecture now, and the Renaissance of classic architecture in the fifteenth century—and one greatly in favour of modern taste,—is that no effort is now made to reconcile styles which depend on opposite causes for their beauty. The modern revival, on the contrary, is marked by an anxiety to purge our churches of the barbarisms of the Debased and pseudo-classic revivals, and to render our national architecture as free as possible from foreign admixture.

If we define the principle of church restoration to be the removal from our churches of everything that is absolutely *incongruous* with their architecture, and if we apply this principle consistently, we shall have no difficulty in ascertaining what is to be retained, and what is to be rejected where several styles of architecture are exhibited in the same edifice.

It is necessary that this definition should be established, because restorers have frequently contented themselves with the object of ascertaining and carrying out the *original idea* of the building restored. Now, what we look upon as a fatal objection to this principle is, that in the majority of cases it is incapable of a practical application. We suppose that there is no one, really zealous for the advancement of pure architecture, who would not rejoice to see every one of our glorious cathedrals thoroughly and efficiently restored; and yet, if the task were to be set about with the view of realising exclusively the intentions of the first founders of these vast piles, which are the growth of successive ages, the most enthusiastic lover of mediæval art most oppose a work which tended rather to destruction than restoration.

Supposing, for instance, it were determined to perfectly restore Ely Cathedral, and suppose ample funds existed for this purpose, so that there were absolutely no restrictions whatever on the efforts of the architect except those imposed by his own taste and judgment—would any one be insane enough to attempt to restore Ely Cathedral to one uniform style? Or, supposing that one style only ought to be retained, by what rule should the selection be directed? Should all the cathedral be destroyed except those parts which exhibit the Norman architecture of the Prior's Entrance?—or, all except the Early English similar to that of the presbytery? —or, all except the Decorated of the choir?—or, all except the Perpendicular of Bishop Alcock's Chapel? Is it not obvious that it would be impossible to retain any one style exclusively?

By what principle then ought the restoration to be directed in the instance supposed? Obviously by this,—of removing all the additions and repairing all the mutilations by which the church has been defaced since the Reformation, and of *retaining the whole of the genuine architecture*. If the different styles adopted by our ancestors had been so essentially discordant as to be absolutely irreconcilable to the same principles of beauty,—if it were impossible that forms successively developed in Christian architecture could be combined harmoniously,—if, in every case where the same building exhibited more than one style, the variety appeared harsh and offensive to the eye,—then, indeed, there might be some pretext for the advocates of uniformity. It is a matter of fact, however, and one that speaks loudly for the merit of Christian architecture, that it *is consistent with itself*, and that different forms of it may exist together without producing a discordant effect. When, indeed, we come to the Debased period, we find contrasts repugnant to pure taste, because arising from the combination of pointed architecture with a style diametrically opposed to it—the Classic. The effect of Grecian mouldings introduced in the woodwork (and sometimes, alas, as in Westminster Abbey, in the masonry) of an English cathedral, is monstrous and insufferable. But the case is altogether different where Norman architecture is combined with Early English or Decorated with Perpendicular: for here, the very fact that each style grew out of the preceding—that there was in each case a Transition style—proves that there cannot be incongruity or discontinuity in these successive developements of mediæval art.

There is moreover a tacit homage paid to the principles of our ancestors by the very act of restoring their architecture, which is inconsistent with the destruction of any part of it. Without adopting a vague admiration of old things simply for their antiquity, independently of their excellence, we yet must concede thus much:—that, in destroying the additions made to our churches after the Reformation, we, in fact, give our adhesion to the architectural principles of those who preceded the Reformation. We say, in fact, this, by our preservation of the existing monuments of Norman and Pointed architecture, that those edifices exhibit merits totally overlooked or mis-apprehended by the classic innovators. Now is it not palpably absurd and inconsistent, when we have made this profession, to destroy any portion of the genuine works of the mediæval architects? Must we not, to speak plainly, condemn this destruction as sheer Vandalism—a Vandalism, too, which is inconsistent with itself, and works all the more fatally because disguised by a profession of reverence for antiquity?

The *restoration* of St. Sepulchre's Church, at Cambridge, was disgraced by this reckless and irremediable desecration. The ancient Perpendicular architecture of the fifteenth century was destroyed in the western part of the building by those who, by a singular perversity, erected at the east a chancel in the Perpendicular style of the *nineteenth* century! And this destruction, under the name of restoration, was the work of those who take to themselves κατ' ἐξοχὴν the character of guardians of English church architecture. Well might M. Didron complain that the injury which modern restorers have, in their self-sufficiency, done to our ancient monuments is far more irreparable than the ravages of time and neglect.

In a recent number of the *Ecclesiologist* we find a complaint of the destruction of the old gateway of the British Museum. This complaint is founded, not on the consideration that the structure has any merit in itself, —it is not attempted to be denied that it is a hideous specimen of bastard architecture,—but simply on the ground that *the architecture is "genuine!"* Senseless inconsistency! A vile mass of brickwork, decorated with some contemptible imitations of Grecian mouldings, is to be preserved, *simply* because it is old; and yet these blind admirers of mere antiquity cannot consent to the preservation of that which is much more ancient, and possesses moreover the merit of architectural beauty and the claim of reverence for sacred places.

It is well nigh time that some effectual means were taken to prevent injuries which once effected are irremediable. We speak thus boldly of them because there is a growing spirit for tampering with ancient architecture in England and France which has already produced the most pernicious effects and tends to produce more. The injuries that have been committed in the cathedral of St. Denis, near Paris, under the pretense of restoration, ought to move the indignation of every lover of Pointed architecture. At Rouen, too, and Amiens (we believe) also, the same work of destruction has been commenced, and under the same pretext. One zealous and uncompromising denouncer of these innovations—M. Didron—has, indeed, been able, in many instances, by the respect attached to his profound antiquarian learning, to restrain the progress of the mischief—and, in a country where the reparation of public monuments is in the hands of the government, his voice must have effect; but here we have no such general supervision, and can only trust to the slow progress of public opinion for the protection of our churches.*

If there must be a destruction of ancient architecture it ought, at least, to proceed on principles which are consistent with themselves, but even this is not the case. Before taking a step which cannot be retraced, the least exercise of prudence is to lay down a general plan of our future progress; and yet, in church-restoration this has been hitherto impossible.

* We do not mean to assert absolutely that it is impossible for a case to arise where the partial demolition of ancient work is justifiable, but we certainly are quite incapable of foreseeing such a case. It may be as well to allude here to to an instance where a laudable work of restoration is likely to be marred by indiscretion in the particular noticed in the text. One of the proposed alterations of Jesus College Chapel, at Cambridge, is the substitution of an Early English east window for that of ancient Perpendicular architecture, at present existing in the choir. On what principle this demolition is commenced it is not very easy to see: it is not even pretended that it will be possible to adopt lancet architecture throughout the entire building, for the Perpendicular windows in the transepts and nave are not to be removed. In fact, a destruction of all the chapel except the lancet architecture would almost involve the rebuilding of the whole edifice. Besides, there is no more reason to retain parts anterior than those posterior to the lancet period, and, to be consistent, the piscina and the Norman gallery in the north transept ought to be destroyed—or rather, if the principle be to carry out the original idea of the edifice, then the Norman ought alone to be retained. If the great east window be, as we believe, the work of Bishop Alcock, the founder of the college, to whom the present institution is chiefly indebted for its existence, respect for his memory should be an additional motive for preserving one, and not the least, of the records of his munificence.

The modern science of mediæval architecture is at present an immature science; every day is adding to our stock of knowledge or correcting false impressions. It is not many years since Rickman introduced the classification and nomenclature of the different styles now in use. How is it possible then that in so brief a period we can have learned all of the science that is worth knowing—that we have now learned so much that we may venture to correct the errors of our teachers, the mediæval architects? At least, there is no harm in waiting awhile till we be *quite* sure that our corrections are not the result of imperfect knowledge.

Of this there will be no debate, that no mischief can arise from confining our endeavours, for the present, to careful reparation. The removal of flat plaster ceilings, of Grecian or Elizabethan screens, of the defilements of stucco, paint and whitewash, and the other inventions of churchwardens and parish architects, are works that may be undertaken without the chance of their propriety being hereafter disputed. Add to these, the repair of parts which have decayed by process of time or been mutilated by violence, the restitution of adornments where clear traces of them remain, and the *scrupulous preservation of every portion of the genuine mediæval architecture*, and we have done all that the present, or, probably, any future, state of our knowledge can justify.

BLAST FURNACE.

Observations on the more recent Researches concerning the Operations of the Blast Furnace in the manufacture of Iron.

By Dr. J. L. Smith.

[From *Silliman's Journal* for March, 1846.]

The great difference existing between metallurgical operations of the present day, and those of a former period, is owing chiefly to the ameliorations produced by the application of the science of chemistry to the *modus operandi* of the various changes taking place during the operations, from their commencement to their termination.

Copper and some other metals are now made to assume forms in the chemist's laboratory, that formerly required great artistical skill for their production—the chemist simply making use of such agents and forces as are at his command, and over which he has, by close analytical study, acquired perfect control. Our object, at present, is only to advert to the chemical investigations more recently made on the manufacture of iron, treating of those changes that occur in the ore, coal, and flux, that are thrown in at the mouth of the furnace, and in the air thrown in from below. For most that will be said on this subject, we are principally indebted to the recent interesting researches of M. Ebelman.

The importance of a knowledge of the facts to be brought forward in this article, will be apparent to every one in any way acquainted with the manu- of iron. It will be seen, that the time is not far distant when the economy in the article of fuel will amount in value to the present profit of many of the works. The consequence must be, that many of those works that are abandoned will be resumed, and others erected in localities formerly thought unfit.

It is well known that the blast furnace is the first into which the ore is introduced, for the purpose of converting it into malleable iron, and much therefore depends upon the state in which the pig metal passes from this furnace, whether subsequent operations will furnish an iron of the first quality or not.

In putting the blast furnace into operation, the first step is to heat it for some time with coal only. After the furnace has arrived at a proper temperature, ore, fuel and flux, are thrown in alternately, in small quantities, so as to have the three ingredients properly mixed in their descent. In from 25 to 48 hours from the time when the ore is first thrown in, the entire capacity of the furnace, from the tuyer to the mouth, is occupied with the ore, fuel, and flux, in their various stages of transformation.

In order to explain clearly, and in as short a space as possible, what these transformations are, and how they are brought about, we may consider:—1. The changes that take place in the descending mass, composed of ore, fuel, and flux.—2. The changes that take place in the ascending mass, composed of air and its hygrometric moisture, thrown in at the tuyer.—3. The chemical action going on between the ascending and descending masses.—4. The composition of the gases in various parts of the furnace during its operation.—5. The causes that render necessary the great heat of the blast furnace.

1. *Changes that take place in the descending mass, composed of ore, coal, and flux.*—By coal is here meant charcoal; when any other species of fuel is alluded to, it will be specified. In the upper half of the fire-room, the materials are subjected to a comparatively low temperature, and they lose only the moisture, volatile matter, hydrogen, and carbonic acid, that they may contain; this change taking place principally in the lower part of the upper half of the fire-room.

In the lower half of the fire-room, the ore is the only material that undergoes a change, it being converted wholly or in part into iron or magnetic oxide of iron—the coal is not altered, no consumption of it taking place from the mouth down to the commencement of the boshes.

From the commencement of the boshes down to the tuyer, the reduction of the ore is completed. Very little of the coal is consumed between the boshes and in the upper part of the hearth; the principal consumption of is taking place in the immediate neighbourhood of the tuyer.

The fusion of the iron and slag occurs at a short distance above the tuyer, and it is in the hearth of the furnace that the iron combines with a portion of the coal to form the fusible carburet or pig-iron. It is also on the hearth that the flux combines with the siliceous and other impurities of the ore. This concludes the changes which the ore, coal, and flux undergo from the mouth of the furnace to the tuyer.

If the fuel used be wood, or partly wood, it is during its passage through the upper half of the fire-room that its volatile parts are lost, and it becomes converted into charcoal. M. Ebelman ascertained that wood, at the depth of ten feet, in a fire-room twenty-six feet high, preserved its appearance after an exposure for 1¾ of an hour, and that the mineral mixed with it preserved its moisture at this depth; but three and a half feet lower, an exposure of 3½ hours reduced the wood to perfect charcoal, and the ore to magnetic oxide. The temperature of the upper half of the fire-room, when wood is used, is lower than in the case of charcoal, from the great amount of heat made latent by the vapour arising from the wood. In the case of bituminous coal, Bunsen and Playfair find that it has to descend still lower before it is perfectly coked.

After the wood is completely charred, or the coal become coked, the subsequent changes are the same that happen in the charcoal furnaces.

2. *Changes that take place in the ascending mass, which is composed of air and hygrometric moisture.*—The weight of the air thrown in at the tuyer in twenty-four hours is twice that of the ore, coal, and flux, thrown in at the mouth during the same time.

The air, as soon as it enters the tuyer and reaches the first portion of coal, undergoes a change—its oxygen is converted into carbonic acid, and its moisture decomposed, furnishing hydrogen and carbonic oxide—after ascending a short distance (12 or 18 inches,) the carbonic acid is converted into carbonic oxide—between this point and the upper part of the boshes it undergoes but very little change, having added to it a further small amount of carbonic oxide. So the ascending column at the top of the boshes is composed of nitrogen, carbonic oxide and hydrogen—from this point it begins to undergo a change; the carbonic oxide diminishes, carbonic acid appears, and goes on increasing for about half the way up the fire-room; after which the carbonic acid, carbonic oxide, and nitrogen remain the same, when the hydrogen increases, and moisture begins to appear and augment up to the mouth. The ascending mass, as it passes out of the mouth, contains the vapour of water, carbonic acid, carbonic oxide, hydrogen, and nitrogen. The nitrogen undergoes no alteration in its passage through the furnace, and the same is true of the hydrogen formed at the tuyer.

If wood be used, the gases passing out of the mouth are the same as those just mentioned, with an increased quantity of moisture, and the addition of those pyroligneous products arising from the dry distillation of wood.

In case of the use of bituminous coal, the gases, first alluded to, have added to them ammonia, light carburetted hydrogen, olefiant gas, carburetted hydrogen of unknown composition, and sulphuretted hydrogen.

3. *The chemical reaction occurring between the ascending and descending masses.*—From the foregoing statements we can at a glance see what are the materials to be met with in the different parts of the furnace, and can therefore readily study their reactions upon each other.

In the upper half of the fire-room little or no chemical action is taking place, the ore, flux, and coal, as already stated, simply losing their volatile parts. In the bottom of the upper half and the entire lower half of the fire-room a reaction is taking place between the ore and the carbonic oxide of the ascending column; iron or magnetic oxide of iron and carbonic acid being the result. It must be borne in mind that the coal has played no part in this reduction down to the commencement of the boshes. Between the boshes, and in the hearth, no reaction appears to take place between the ascending and descending masses, but the reduction of the ore is completed by the direct action of the coal upon the remaining portion of the undecomposed ore; carbonic oxide being formed;—and here is the first consumption of the coal in its passage downwards.

According to M. Ebelman, the ore loses in the fire-room $\frac{9}{13}$ of its oxygen by the reaction of the oxide of carbon, and the remaining $\frac{4}{13}$ disappears in the boshes and hearth, in the manner already stated, at the expense of from $\frac{8}{100}$ to $\frac{12}{100}$ of the entire amount of charcoal used.

The ore being now completely reduced, unites with a portion of carbon in the hearth, melts at about 13 inches from the tuyer, and descends into the crucible; and here also the flux, combining with the impurities of the ore, forms the slag, which melts.

The coal and the air react upon each other most powerfully, just in the neighbourhood of the tuyer, where the most intense heat is produced; the oxygen becomes converted into carbonic acid, which acting upon a portion of the ignited coal, is almost at the same moment reduced to carbonic oxide; the moisture of air acting on the ignited charcoal undergoes the decomposition already mentioned, hydrogen and carbonic oxide resulting therefrom.

When the ore is easy of reduction, the gas at the boshes is represented by 100 nitrogen and 52·5 carbonic oxide, *plus* the quantity of carbonic oxide and hydrogen afforded by the moisture.

It must be clearly understood, that these rules do not apply to every variety of ore. They are especially applicable to the hemetites and such ores as are either naturally porous or become so in their passage through the fire-room of the furnace, thus increasing the surface of contact exposed to the action of the reducing agent (carbonic oxide), so that when it has reached the boshes the reduction is nearly complete.

The specular, magnetic, and siliceous ores, are reduced with much more difficulty; most of the ore, in these cases, reaching the boshes but slightly altered, they being principally dependent upon the direct action of coal for their reduction. This circumstance largely increases the consumption of coal when any of these ores are employed; and the amount of caloric made latent, in consequence of the reduction requiring the direct action of the coal, is very great; whereas in the reduction of the ore by carbonic oxide no heat becomes latent, for the heat rendered latent by the oxygen of the ore becoming gaseous, is compensated by the sensible heat produced by the combination of the carbonic oxide with the oxygen. Where the reduction is produced by the carbon, with the formation of carbonic oxide, 1598 unities of heat are made sensible, while 6216 are rendered latent, giving a difference of absolute loss of 4618.

It should be the object of the metallurgist to reduce as much of the iron as possible by the oxide of carbon. Magnetic, siliceous, and other hard ores, should be reduced to smaller fragments than those softer and more easily managed. Were it possible to reduce them to powder without the danger of choking the furnace, it would be all the better, as the great object is to have a large extent of surface exposed to the carbonic oxide. The different capacity of different ores for reduction shows the necessity of having furnaces of different dimensions for them respectively.

The matter which covers the melted metal in the crucible, and that which adheres to the interior of the hearth, contains silicate of iron and charcoal in a pasty state, and there is consequently a constant reduction of the oxide of iron, which gives rise to carbonic oxide; this gas bubbles through the slag, which, if drawn off at this time, will, when cold, present a porous structure,—a sure indication that the furnace is not working well, and that the slag itself contains much of the ore in the form of a silicate.

4. *Composition of the gas in various parts of the furnace during its operation.*—The analyses lately made by Ebelman are the most accurate and best detailed that we are in possession of. What follows has reference to a furnace worked with charcoal.

Gas taken from the mouth of the furnace and dried:—

Carbonic acid	12·88
Carbonic oxide	28·51
Hydrogen	5·82
Nitrogen	57·79

The vapour of water in a hundred volumes of this gas, varies from nine to fourteen volumes. Examinations made at different times show the proportion of hydrogen and nitrogen to be nearly uniform, and that the sum of the volumes of carbonic acid and carbonic oxide is constant, but that there is a variation in their respective proportions.

Gas taken from the interior of the fire-room at 5 *to* 10, *and* 13 *to* 17 *feet from the mouth (fire room* 36 *feet).* From five to ten feet the proportion of moisture diminishes, the other ingredients remaining about the same. From 13 to 17 feet the proportion of carbonic oxide increases, while the carbonic acid and hydrogen diminish.

Gas from the bottom of the fire-room and top of the boshes:—This is remarkable for the constancy of its composition, and for the absence of carbonic acid and watery vapour. Composition:—

Carbonic oxide	35·01
Hydrogen	1·92
Nitrogen	63·07

Gas from the bottom of the boshes and commencement of the hearth:—

Carbonic acid	0·31
Carbonic oxide	41·59
Hydrogen	1·42
Nitrogen	56·68

Gas from the neighbourhood of the tuyer:—

Carbonic oxide	51·35
Hydrogen	1·25
Nitrogen	47·40

The two last statements would appear to contradict the rules previously laid down, as regulating the operation of the blast furnace; for, according to them, the proportion of carbonic oxide, at the top of the boshes, should be a little greater than in the hearth, whereas the reverse would appear to be the case by the analyses here given. Besides, from a glance at the composition of the three last gases alluded to, it would appear that the gaseous products, as they ascended the furnace, lost completely a portion of the carbonic oxide, without a replacement by carbonic acid or other compound; in other words, a portion of it would appear to be completely annihilated, which of course is an impossibility. This apparent anomaly is easily accounted for, when it is stated how the gas was collected.

In order to obtain the gas from different portions of the furnace, holes were bored into the side, and a tube inserted, by which it was drawn off. Allusion has already been made to the fact that a pasty mass adheres to the sides of the hearth, containing silicate of iron and charcoal, in which there is a constant reduction of the iron, with the formation of carbonic oxide. Now it is evident that the gas drawn off by a hole bored into the side of the hearth, will be largely mixed with this carbonic oxide forming in the immediate neighbourhood of the opening, and that it cannot serve as an index to the character of gas passing through the centre of the hearth. M. Ebelman was aware of this fact, but he was not able to overcome the difficulties in the way of obtaining the gas under the proper circumstances.

Gas taken at the tuyer.—Here it is little else than atmosphere mixed with a few per cent. of carbonic acid.

From these results it will not be difficult to admit, that the oxygen of the air is converted immediately into carbonic acid, which is rapidly changed into carbonic oxide, under the influence of an excess of carbon and the high temperature developed near the tuyer.

5. *The causes that render necessary the great heat of the blast furnace.*—The weight of the ore, flux, and combustible, which enters the furnace, being only one-half that of the ascending column, and as the specific heat of these three materials is very much below that of the gas of the ascending mass, it is not the heating of them that explains the necessity of the very great heat of the blast furnace. But the principal cooling causes are,—

1. The drying of the ore, flux, and coal, and the expulsion of carbonic acid from the flux, &c., rendering much of the heat latent; for what was solid is now transformed to the gaseous state.

2. The reduction of the ore, or in other words, the transformation of the solid oxygen of the ore into gaseous oxygen. If the ore has been deprived of its oxygen by the action of carbonic oxide, with the formation of carbonic acid, the heat rendered latent by the oxygen, is compensated for by the heat developed by the reaction between the oxygen and carbonic oxide; which is the character of the operation that principally takes place in the lower part of the fire-room. If the ore has been deprived of its oxygen by the direct action of the coal, the amount of heat rendered latent is enormous, as already stated; for carbonic oxide is the result of this reaction, and the amount of heat developed by it falls far short of that rendered latent by the oxygen that has entered into its formation, assuming the gaseous condition,—this is the character of the reduction taking place in the boshes and hearth.

3. The conversion of the carbonic acid near the tuyer into carbonic oxide has a powerful influence in cooling the upper part of the hearth; for of the 6260 units of heat formed by the first action of the air upon the coal, 4662 are rendered latent by the conversion of this carbonic acid into carbonic oxide.

This terminates what it was proposed to treat of; it is little else than a sketch of the chemistry of the blast furnace, sufficient to show its importance.

In a future article, some remarks will be made upon the amount of combustible lost in the operation of this furnace, the recent methods employed to prevent this loss in the complete combustion of coal, the action of the hot blast, theory of the refining furnace, charring of wood, and other points of interest.

STEPHENSON'S TUBULAR BRIDGE.

Mr. Fairbairn's Report.

Abstract or short Summary of Results from Experiments relative to the proposed Bridge across the Menai Straits, addressed to Robert Stephenson, Esq. By. W. Fairbairn.

After a series of experiments undertaken at your request, for ascertaining the strongest form of a Sheet Iron Tubular Bridge across the Menai Straits, I have been induced, in order to meet the requirements for such a structure, and to ensure safety in the construction, to call in the aid and assistance of my friend Mr. Hodgkinson.

The flexible nature of the material, and the difficulties which presented themselves in retaining the lighter description of tubes in shape gave exceedingly anomalous results; and having no formula on which dependence could be placed for the reduction of the experiments, I deemed it necessary, in a subject of such importance, to secure the co-operation of the first authority, in order to give confidence to the Chester and Holyhead Railway Company, with whom you are connected, and the public generally.

It will be observed, that the first class of experiments is upon cylindrical tubes;—the second upon those of the elliptical form;—and the last upon the rectangular kind. Tubes of each sort have been carefully tested, and the results recorded in the order in which they were made; and moreover, each specimen had direct reference to the intended Bridge, both as regards the length and thickness, as also the depth and width.

In the first class of experiments, which are those of the cylindrical form, the results are as follow:

CYLINDRICAL TUBES.

No. of Experiments.	Distance between the supports. ft.	in.	Diameter in Inches.	Thickness of Plate in inches.	Ultimate Deflection in Inches.	Breaking weight in lb.	Remarks.
1	17	0	12·18	·0408	·39	3,040	Crushed top.
2	17	0	12·00	·0370	·65	2,704	Ditto.
3	15	7½	12·40	·1810	1·29	11,440	Torn asunder at the bottom.
4	23	5	18·26	·0582	·56	6,400	Ditto.
5	23	5	17·68	·0631	·74	6,400	Ditto.
6	23	5	18·18	·1190	1·19	14,240	Ditto.
7	31	3¼	24·00	·0954	·63	9,760	Ditto.
8	31	3¼	24·30	·13601	·95	14,240	Ditto.
9	31	3¼	24·20	·0954	·74	10,680	Ditto.

With the exception of the first two, nearly the whole of the tubes were ruptured by tearing asunder at the bottom through the line of the rivets.

Finding the cylindrical form comparatively weak, the next experiments were upon tubes of the rectangular shape, which gave much better results. For the present it may, however, be more convenient to take the elliptical kind, as being the nearest approximation, as regards both form and strength, to the cylinders recorded above.

ELLIPTICAL TUBES.

No. of Experiments.	Distance between the supports. ft.	in.	Diameters, transverse and conjugate in inches.	Thickness of Plates in inches.	Ultimate Deflection in inches.	Breaking weight in lb.	Remarks.
19	17	0	14·62 / 9·25	·0416	·62	2,100	Crushed on top.
20	24	0	21 66 / 13·50	1·1820	1·86	17,076	Broke by extension.
21	24	0	21·25 / 14·12	·0688	·45	7,270	By compression.
22	18	6	12 ·00 / 7 ·50	·0775	·95	6,867	By compression. This tube had a fin on the top side.
24	17	6	15·00 / 9·75	·1430	1·39	15,000	Both sides were ruptured.

It will be observed that the whole of these experiments indicated weakness on the top side of the tnbe, which, in almost every case, was greatly distorted by the force of compression acting in that direction. It is probable that those of the cylindrical form would have yielded in like manner, had the rivetting at the joints been equally perfect on the lower side of the tube. This was not, however, the case, and hence arise the causes of rupture at that part.

The next experiments, and probably the more important, were those of the rectangular kind; they indicate a considerably increased strength when compared with the cylindrical and elliptical forms: and, considering the many advantages which they possess over every other yet experimented upon, I am inclined to think them not only the strongest but the best adapted (either as regards lightness or security) for the proposed Bridge.

RECTANGULAR TUBES.

No. of Experiments.	Distance between Supports ft.	in.	Depth in inches	Width in inches.	Thickness of Plate in inches. top.	bottom.	Ultimate Deflection in inches.	Breaking Weight in lb.	Remarks.
14	17	6	9·6	9·6	·075	·075	1·10	3,738	Broke by Compression.
14	17	6	9·6	9·6	·272	·075	1·13	8.273	(Reversed.) Extens.
15	17	6	9·6	9·6	·075	·142	0·94	3,788	Compression.
15	17	6	9·6	9·6	·142	·075	1·88	7.148	Extension.
16	17	6	18·25	9·25	·059	·149	0·93	6,812	Compression.
16	17	6	18·25	9·25	·149	·059	1·73	12,188	Ditto.
17	24	0	15·00	2·25	·160	·160	2·66	17,600	Ditto.
18	18	0	13 25	7·50	·142	·142	1·71	13,680	Ditto.
23	18	6	13·00	8·00	·066	·066	1·19	8,812	Compression. Circular bottom, fin at top.
29	19	0	15·40	7·75	·230	·180	1·59	22,469	Sides distorted. Corrugated top.

On consulting the above table, it will be found that the results as respects strength are of a higher order than those obtained from the cylindrical and elliptical tubes; and particularly those constructed with stronger plates on the top side, which, in almost every experiment where the thin side was uppermost, gave signs of weakness in that part. Some curious and interesting phenomena presented themselves in these experiments,—many of them are anomalous to our preconceived notions of the strength of materials,—and totally different to any thing yet exhibited in any previous research. It has invariably been observed, that in almost every experiment the tubes gave evidence of weakness in their powers of resistance on the top side, to the forces tending to crush them. This was strongly exemplified in experiments 14, 15, 16, &c., marked on the drawings and the table. With tubes of a rectangular shape, having the top side about double the thickness of the bottom, and the sides only half the thickness of the bottom, or one-fourth the thickness of the top, nearly double the strength was obtained. In experiment 14, (marked in the margin of the above table,) a tube of the rectangular form, 9½ inches square, with top and bottom plates of equal thickness, the breaking weight was 3,738 lb.

Rivetting a stronger plate on the top side,
the strength was increased to .. 8,273 lb.

The difference being 4,535 lb.,—considerably more than double the strength sustained by the tube when the top and bottom sides were equal.

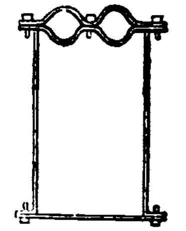
The experiments given in No. 15 are of the same character, where the top plate is as near as possible double the thickness of the bottom. In these experiments, the tube was first crippled by doubling up the thin plate on the top side, which was done with a weight of .. 3,788 lb.

It was then reversed with the thick side upwards, and by
this change the breaking weight was increased to .. 7,148

Making a difference of .. .. .. 3,360 lb.

or an increase of nearly double the strength, by the simple operation of reversing the tube, and turning it upside down.

The same degree of importance is attached to a similar form, when the depth in the middle is double the width of the tube. From the experiments in No. 16, we deduce the same results in a tube where the depth is 18¼, and the breadth 9¼ inches. Loading this tube with 6,812 lb. (the thin plate being uppermost), it follows precisely the same law as before, and becomes wrinkled, with a hummoc rising on the top side so as to render it no longer safe to sustain the load. Take, however, the same tube, and reverse it with the thick plate upwards, and you not only straighten the part previously injured, but you increase the resisting powers from 6,812 lb. to 12,188 lb. Let us now examine the tube in the 29th experiment, where the top is composed of corrugated iron, as per sketch, forming two tubular cavities extending longitudinally along its upper side. This, it will be observed, presents the best form for resisting the "puckering," or crushing force, which, on almost every occasion, was present in the previous experiments. Having loaded the tube with increasing weights, it ultimately gave way by tearing the sides from the top and bottom plates, at nearly one and the same instant after the last weight, 22,469 lb., was laid on. The greatly increased strength indicated by this form of tube, is highly satisfactory, and provided these facts be duly appreciated in the construction of the bridge, they will, I have no doubt, lead to the balance of the two resisting forces of tension and compression.



The results here obtained are so essential to this enquiry, and to our knowledge of the strength of materials in general, that I have deemed it essential, in this abridged statement, to direct attention to facts of immense value in the proper and judicious application, as well as distribution, of the material in the proposed structure. Strength and lightness are desiderata of great importance,—and the circumstances above stated are well worthy the attention of the mathematician and engineer.

For the present we shall have to consider not only the due and perfect proportion of the top and bottom sides of the tube; but also the stiffening of the sides with those parts, in order to effect the required rigidity for retaining the whole in shape. These are considerations which require attention: and till further experiments are made, and probably some of them upon a larger scale, it would be hazardous to pronounce anything definite as to the proportion of the parts, and the equalization of the forces tending to the derangement of the structure.

So far as our knowledge extends,—and judging from the experiments already completed,—I would venture to state that a tubular bridge can be constructed, of such powers and dimensions as will meet, with perfect security, the requirements of railway traffic across the Straits. The utmost care must, however, be observed in the construction, and probably a much greater quantity of material may be required, than was originally contemplated before the structure can be considered safe.

In this opinion Mr. Hodgkinson and myself seem to agree: and although suspension chains may be useful in the construction in the first instance, they would nevertheless be highly improper to depend upon as the principal support of the bridge. Under every circumstance, I am of opinion that the tubes should be made sufficiently strong to sustain not only their own weight, but in addition to that load, 2,000 tons equally distributed over the surface of the platform, a load ten times greater than they will ever be called upon to support. In fact, it should be a huge sheet iron hollow girder, of sufficient strength and stiffness to sustain those weights; and, provided the parts are well proportioned, and the plates properly rivetted, you may strip off the chains, and leave it as a useful monument of the enterprise and energy of the age in which it was constructed.

In the pursuit of the experiments on the rectangular as well as other description of tubes, I have been most ably assisted by my excellent friend Mr. Hodgkinson; his scientific and mathematical attainments render him well qualified for such researches; and I feel myself indebted to him for the kind advice and valuable assistance which he has rendered in these and other investigations. I am also deeply indebted to yourself and the Directors for the confidence you have placed in my efforts, and for the encouragement I have uniformly received during the progressive development of this enquiry.

But, in fact, the subject is of such importance, and the responsibilities attached to it are so great, as to demand every effort to demonstrate, calculate, and advise what in this case is best to be done. Both of us have therefore laboured incessantly at the task, and I am indebted to my friend for the reduction of the experiments which I would not attempt to weaken by a single observation.

Wm. Fairbairn.

Mr. Hodgkinson's Report.

Summary of Results offered, in conjunction with one by William Fairbairn, Esq., M. Inst. C. E., *to* Robt. Stephenson, Esq, M. Inst. C.E., &c., &c., *for the Directors of the Chester and Holyhead Railway, on the subject of a proposed Bridge across the Menai, near to Bangor.—By* Eaton Hodgkinson, F.R.S.

Having in the month of August last year been requested to render assistance, principally in a scientific point of view, with respect to the experiments to ascertain the practicability of erecting a Tubular Bridge across the Menai Straits, of sufficient strength for railway trains to pass through it with safety, I attended twice in London for that purpose: and as the experiments made there were on tubes of various forms of section, including several elliptical and circular ones, I investigated formulæ for reducing the strength of the leading ones. It appeared evident to me, however, that any conclusions deduced from received principles, with respect to the strength of thin tubes, could only be approximations; for these tubes usually give way by the top or compressed side becoming wrinkled, and unable to offer resistance, long before the parts subjected to tension are strained to the utmost they would bear. To ascertain how far this defect, which had not been contemplated in the theory, would affect the truth of computations on the strength of the tubes proposed to be used in the bridge,—and also to show whether the principles generally received could be applied with certainty in reasoning as to the strength of the bridge from that of models comparatively very small,—for these two purposes I urged the necessity of a number of fundamental experiments, which, besides supplying the wants above mentioned, might enable me to obtain additional information to that from Mr. Fairbairn's experiments, with respect to the proportions that the different parts of the section of such a bridge ought to have, as well as what form it should be of, in order to bear the most.

Feeling that there might be objections against allowing me to follow the courses I proposed, however necessary it might appear to myself, I suggested a much more limited series of experiments than now appear to me to be necessary; and, as the time consumed in getting the plates rolled and the tubes prepared, caused the experiments to be delayed till the beginning of the year, the time given me has beeen too limited to obtain all the facts which the few experiments proposed would have afforded.

I will now give the results, so far as they have been obtained and seem worthy of reliance, subject to correction from future experiments; beginning with the reduction of Mr. Fairbairn's experiments on the strength of tubes of wrought iron made of plates rivetted together.

Cylindrical Tubes.—The strength of a cylindrical tube, supported at the ends, and loaded in the middle, is expressed by the formula

$$w = \frac{\pi f}{a\,l}\,(a^4 - a'^4).$$

Where l is the distance between the supports; a, a' the external and internal radii; w the breaking weight; f the strain upon a unity of section, as a square inch, at the top and bottom of the tube, in consequence of the weight w; $\pi = 3{\cdot}14159$.

From this formula we obtain

$$f = \frac{w\,l\,a}{\pi\,(a^4 - a'^4)}.$$

As it will be convenient to know the strain f per square inch, which the metal at the top and bottom of the tube is bearing when rupture takes place, this value will be obtained from each of Mr. Fairbairn's experiments: the value w being made to include, besides the weight laid on at the time of fracture, the pressure from the weight of the tube between the supports, this last being equal to half that weight. Computing the results we have, from

$$\left.\begin{array}{ll} \text{Experiment } 1, & f = 33456 \\ \quad\;\; ,, \quad 2, & f = 33426 \\ \quad\;\; ,, \quad 3, & f = 35462 \\ \quad\;\; ,, \quad 4, & f = 32415 \\ \quad\;\; ,, \quad 5, & f = 30078 \\ \quad\;\; ,, \quad 6, & f = 33869 \\ \quad\;\; ,, \quad 7, & f = 22528 \\ \quad\;\; ,, \quad 8, & f = 22655 \\ \quad\;\; ,, \quad 9, & f = 25095 \end{array}\right\}\ \text{Mean 29887 lb.} = 13{\cdot}34 \text{ tons.}$$

Fracture in all cases took place either by the tube failing at the top, or tearing across at the rivet holes; this happened on the average, as appears from above, when the metal was strained 13½ tons per square inch, or little more than half its full tensile strength.

Elliptical Tubes.—The value of f in an elliptical tube broken as before, (the transverse axis being vertical), is expressed by the formula

$$f = \frac{w\,l\,a}{\pi\,(b\,a^3 - b'\,a'^3)}.$$

Where a, a' are the semitransverse external and internal diameters; b, b' the semi-conjugate external and internal diameters; and the rest as before, w including in all cases the pressure from the weight of the beam.

Computing the results from Mr. Fairbairn's experiments we have from

$$\left.\begin{array}{ll} \text{Experiment } 20, & f = 36938 \text{ lb.} \\ \quad\;\; ,, \quad 21, & f = 29144 \\ \quad\;\; ,, \quad 24, & f = 45185 \end{array}\right\}\ \text{Mean 37089 lb.} = 16{\cdot}55 \text{ tons.}$$

Rectangular Tubes—If in a rectangular tube, employed as a beam, the thickness of the top and bottom be equal, and the sides are of any thickness at pleasure, then we have

$$f = \frac{3\,w\,l\,d}{2\,(b\,d^3 - b'\,d'^3)}.$$

in which d, d' are the external and internal depths respectively; b, b' the external and internal breadths; and the rest as before.

Mr. Fairbairn's experiment No. 14 gives by reduction

$$f = 18495 \text{ lb.} = 8{\cdot}2566 \text{ tons.}$$

This is, however, much below the value which some of my own experiments give, as will be seen further on.

The value of f, which represents the strain upon the top or bottom of the tube when it gives way, is the quantity per square inch which the material will bear either before it becomes crushed at the top side or torn asunder at the bottom. But it has been mentioned before, that thin sheets of iron take a corrugated form with a much less pressure than would be required to tear them asunder; and therefore the value of f, as obtained from the preceding experiments, is generally the resistance of the material to crushing, and would have been so in every instance if the plates on the bottom side (subjected to tension) had not been rendered weaker by rivetting.

The experiments made by myself were directed principally to two objects:—

I.—To ascertain how far this value of f would be affected by changing the thickness of the metal, the other dimensions of the tube being the same.

II.—To obtain the strength of tubes, precisely similar to other tubes fixed on,—but proportionately less than the former in all their dimensions, as length, breadth, depth, and thickness,—in order to enable us to reason as to strength from one size to another, with more certainty than hitherto, as mentioned before. Another object not far pursued, was to seek for the proper proportion of metal in the top and bottom of the tube. Much more is required in this direction.

In the three series of experiments made, the tubes were *rectangular*, and the dimensions and other values are given below.

Length.		Depth.	Breadth.	Distance between supports		Weight.		Thickness of Plates.	Last observed Deflection.	Corresponding Weight.	Breaking Weight.	Value of f, for crushing Strain.
ft.	in.	In.	In.	ft.	in.	cwt.	qr.	Inch.	Inch.	Tons.	Tons.	Tons.
31	6	24	16	30	0	44	3	·525	3·03	56·3	57·5	19·17
31	6	24	16	30	0	24	1	·272	1·53	20·3	22·75	14·47
31	6	24	16	30	0	10	1	·124	1·20	5·04	5·53	7·74
						lb.	oz.			lb.	lb.	
8	2	6	4	7	6	78	13	·132	·66	9,416	9,976	23·17
8	2	6	4	7	6	38	11	·065	·32	2,696	3,156	15·31
8	2	6	4	7	6	..		..	..	..	..	..
4	2¼	3	2	3	9	10	12	·061	·435	2,464	2,464	24·56
4	3¼	3	2	3	9	4	15	·03	·13	560	672	13·42

The tube placed first in each series, is intended to be proportional in every leading dimension, as distance between supports, breadth, depth, and thickness of metal,—and any variations are allowed for in the computation. Thus the three first tubes of each series are intended to be similar; and in the same manner of the other tubes, &c.

Looking at the breaking weights of the tubes varying only in thickness, we find a great falling off in the strength of the thinner ones; and the values of f show that in these—the thickness of the plates being ·525, ·272, ·124 inch—the resistance, per square inch, will be 19·17, 14·47, and 7·74 tons respectively. The breaking weights here employed, do not include the pressure from the weight of the beam.

The value of f is usually constant in questions on the strength of bodies of the same nature, and represents the tensile strength of the material, but it appears from these experiments that it is variable in tubes, and represents their power to resist crippling. It depends upon the thickness of the matter in the tubes, when the depth or diameter is the same; or upon the thickness divided by the depth when that varies. The determination of the value of f, which can only be obtained by experiment, forms the chief obstacle to obtaining a formula for the strength of tubes of every form. When f is known the rest appears to depend upon received principles, and the computation of the strength may be made as in the Application de la Mécanique of Navier, Part 1st, Article IV.; or as in Papers of my own in the Memoirs of the Literary and Philosophical Society of Manchester, vols 4 and 5, second series. I have, however, made for the present purpose, further investigations on this subject, but defer giving them till additional information is obtained on the different points alluded to in this report; and this may account for other omissions.

In the last table of experiments the tubes were devised to lessen or to avoid the anomalies which rivetting introduces, in order to render the properties sought for more obvious. Hence, the results are somewhat higher than those which would be obtained by rivetting as generally applied.

The tube 31 feet 6 inches long, 24 cwt. 1 qr. weight, and ·272 inch in thickness of plates, was broken by crushing at the top with 22·75 tons. This tube was afterwards rendered straight, and had its weak top replaced by one of a given thickness, which I had obtained from computation; and the result was, that by a small addition of metal, applied in its proper proportion to the weakest part, the tube was increased in strength from 22·75 tons to 32·53 tons; and the top and the bottom gave way together.

If it be determined to erect a bridge of tubes, I would beg to recommend that suspension chains be employed as an auxiliary, otherwise great thickness of metal would be required to produce adequate stiffness and strength.

EATON HODGKINSON.

TIDAL HARBOURS.

Second Report of the Commissioners.

A more extended inquiry has fully confirmed the views which the limited examination of last year led us to submit to your majesty. Not only is there a general want of control over the management and revenue of the ports, but there is not a single exception among the numerous cases which have come before us in which such a control might not have been the means of saving unnecessary outlay; of preventing encroachments that can now scarcely be remedied; or of stopping works that must be removed in order to secure the objects to which the attention of the commission is directed.

The necessity of such supervision has also become more apparent since the publication of the returns to the orders of the House of Commons of August last, from which we learn that the income of the various ports of the United Kingdom considerably exceeds the sum of £800,000 a year—the whole levied by charters and acts of Parliament, or otherwise, from dues on shipping, and on goods borne by shipping, but over the expenditure of which Parliament has not at present the slightest control.

That much of this money has been and is misapplied will excite no surprise, when we find that several harbours are governed by numerous self-elected, irresponsible Commissioners, (in some places exceeding even 100 in number), often conducting their proceedings in private, auditing their own accounts, publishing no statement of income or expenditure, and laying out large sums of money without the advice of an engineer; and that these commissioners are frequently landed proprietors, sometimes non-resident, and occasionally a shipowner, but rarely a sailor among them. Such, however, is the constitution of many of the harbour boards of this country, acting under authority conferred by Parliament.

Since the date of our first report we have, in compliance with that clause of her Majesty's Commission which directs us to visit and personally inspect all the harbours and shores of the United Kingdom, examined the chief ports on the east coast of England, from the river Thames to the Tyne, thus including Yarmouth, Hull, and the principal coal ports of Durham and Northumberland, which, owing to the extraordinary increase in steam navigation, are daily rising into greater importance.

On the west coast we have personally inspected the rivers Lune, Wyre, Ribble, and Dee; and the ports of the Isle of Man, which, although of small extent as harbours, become of consequence from their position in the centre of the Irish Channel, and as the head-quarters of an extensive and increasing fishing trade.

In Ireland we have been enabled to visit most of the ports and fishing-piers around the coast, and have been strongly impressed by a sense of the great value of its natural harbours, their depth and capacity, and the extent and capability for improvement of its fisheries, which, even in their present state, and with the fishery-piers often in ruins from neglect, afford employment to 19,880 vessels and boats, and 93,000 hardy fishermen.

But these natural advantages are very far from having been turned to the best account.

The harbour of Dublin and the river Liffey offer an instructive example of the correctness of this statement. Within the last 30 years many improvements have taken place. The depth of water over the bar and up to the city quays has been increased several feet, by dredging, and by the bold measure of running out the great north wall. The traffic and consequent revenue of the port have more than doubled, and the latter has risen to £34,000 a year. Yet the evidence shows that the foundation of the quay is generally so imperfect that they will not, in their present state, admit of the river being further deepened; that the south quay, the resort of three-fourths of the shipping of the port, is encumbered at its foot by heaps of mud; that the entrance into the grand canal dock is all but blocked up by sand-banks; that there is a great want of graving docks; that there is but one public crane; that the port charges are very high; and that the ballast, of which, by Act of Parliament, the ballast-office has a monopoly, and for which it charges about double the market price, is in many cases bad.

The Isle of Man occupies an important position in the Irish Channel, directly in the track of communication between Liverpool, Glasgow, and Belfast, and of the coal trade from Whitehaven and Maryport to the whole of the east coast of Ireland. It has been aptly termed the "Beacon of the Irish Sea," and as such everything that care and skill can suggest, as to lights, beacons, and improvement of its harbours, would be well bestowed, and tend to prevent that recurrence of the numerous wrecks that have taken place around its shores. Yet such is far from being now the case; on the contrary (with the exception of the coast lights maintained by the Board in Scotland), marked neglect prevails throughout; and here the evils of irresponsible, self-elected authority are but too manifest, the commissioners meeting only once a year to go through the form of auditing their own accounts, keeping no regular minutes of their proceedings, and practically leaving the whole power and authority in the hands of a single person.

On the north-west coast of England, the river Lune and the port of Lancaster are capable of much improvement.

The river Ribble and port of Preston offer a proof also of the value of skilful engineering, as applied to navigable rivers. Only five years since, spring tides rose but six feet, and neap tides not at all, at Preston quay, so that vessels were obliged to unload their cargoes at Lytham, near the mouth of the river, and send them up to Preston in lighters or flats drawing but six feet of water; whereas now, by means of straightening the channel, and deepening its bed, spring tides rise ten feet, and vessels of 200 tons, drawing eleven feet of water, come up to the quay.

It appears from the Parliamentary returns that the aggregate debt of the several ports of the United Kingdom, exclusive of docks in the port of London, exceeds £4,000,000 sterling; one-fourth part, therefore, of the whole harbour income of £800,000 a year must be annually appropriated to pay the interest of this debt, which will consequently materially cripple the means for future improvements. This large sum, although borrowed with the sanction of the Legislature, has been laid out entirely by the several local boards, without the slightest control being exercised over it either by Parliament, or by any other power specially charged to watch over the interests of the public.

Among the numerous cases of the misapplication of the harbour funds, to which we have already had occasion to refer, the sum of more than £28,000 expended last year in Parliamentary and legal expenses connected with bills for the improvement of harbours, seems to your commission to be a most impolitic unnecessary outlay, and one which might be entirely prevented by the establishment of a Harbour Conservancy Board, such as we have humbly ventured to submit for your Majesty's consideration.

From the competition already commenced between railroads and the coasting shipping, we fear that unless immediate measures be taken to improve the harbours and navigable rivers of this kingdom, and, where practicable, to lessen the dues, a large portion of the goods which these vessels now carry will soon be conveyed by the railroads rapidly extending to almost every part of the coast. We would, therefore, strongly urge such assistance, not only on economical but on political grounds of the highest importance to the maritime interests of the kingdom, as the coasting trade has ever been the best nursery for the hardy race of seamen who have so ably maintained the honour and power of the country.

We alluded in our first report to the obstructions and shoals which so seriously impede and endanger the navigation of the Thames, between Gravesend and London-bridge; all the additional information and evidence we have received since that report was presented, fully convince us of the correctness of the opinions we then expressed, and we feel confident that, if the various and frequently conflicting authorities to whose guardianship the conservancy of this noble river is entrusted, could be induced to co-operate cordially in its improvement, and to carry on their operations jointly on one sound and uniform system, the impediments which now discredit the local administrations and endangered the commerce of the metropolis, might be speedily and cheaply removed. And in strong corroboration of our own view of this subject, we subjoin the following extract from the report of a select committee of the House of Commons in the year 1836, specially appointed to inquire into the state of the port of London:—

"That this committee are of opinion that the various conflicting jurisdictions and claims of the Admiralty, the Trinity House, and the Corporation of the City of London over the river Thames below the bridges, have had a most injurious effect upon the interests of navigation; that it is desirable they should be consolidated and vested in some one responsible body, and that means should be found to provide for the removal of shoals and obstructions in the bed of the river."

All these facts and considerations induce us most earnestly to repeat the recommendation, which we ventured dutifully to submit to your Majesty in our former report, that all the tidal harbours in the United Kingdom be placed under the special care of a board of conservancy, to be formed under the authority and provisions of an act of Parliament, being fully convinced that any less stringent and decisive measures will be found wholly inadequate for the accomplishment of the great national object which your Majesty has been graciously pleased to direct us to consider and examine.

All which we humbly certify to your Majesty,

W. Bowles, Rear-Admiral, M.P., Chairman.
J. J. Gordon Bremer, Captain R.N.
Joseph Hume, M.P.
Aaron Chapman, M.P.
Edward R. Rice, M.P.
Thomas Baring, M.P.
F. Beaufort, Hydrographer.
G. B. Airy, Astronomer Royal.
John Washington, Captain R.N.
Richard Godson, Q.C. and M.P., Counsel to the Admiralty.

London, March 20, 1846.

The Value of Smoke.—A striking instance of economic talent came to our knowledge in the district of Alston Moor. From the smelting earths of one "house," an arched tunnel conducts the smoke to an outlet at a distance from the works, in a waste spot, where no one can complain of it. The gathering matter or "fume" resulting from the passage of the smoke is annually submitted to a process, by which at that time it yielded enough to pay for the construction of a chimney. A similar tunnel chimney three miles in length was erecting at Allendale. Its fume will yield thousands of pounds sterling per annum. Truly, here it may be said that smoke does not end in smoke.—'British Quarterly Review.'

PAINTING ON GLASS.

There are three kinds of paintings on glass: paintings with the different colours on separate pieces of glass, painting on uncoloured glass, and painting on crystal. The first two methods are frequently combined so as to constitute a fourth kind of painting on glass. The first kind of painting is incontestably the most ancient. Glass is prepared in sheets, blue, violet, yellow, green, and red, and after being divided into pieces of the proper size and shape, the separate portions are put together by glaziers' lead.

The preparation of purple glass has fallen into such disuse, that till very recently, the art was considered to be entirely lost, but this is not the case, for there still exist printed receipts which describe all the details of the operation. Baptiste Porta, who was born in the year 1540, has given one of the receipts in his *Magie Naturelle*, and he has taken care at the same time to warn us of the difficulty of obtaining a successful result. Other receipts are found in the compilations of Néri, Merret, and Kunckel, and have been transferred to the encyclopædia. No information, however is given respecting red glass. It is not prepared with the purple of gold, for this substance gives neither a scarlet red nor the red, of clear wine: Instead of oxyde of iron, the protoxyde of copper is used. But as this last produces an exceedingly deep colour which deprives the glass of its transparency, the usual plan is to cover white glass with a thin layer of red glass, so as to form a kind of plated glass. The process is as follows—there are placed in the furnace two crucibles, of which one contains common glass, the other glass of the same composition, but coloured with protoxyde of copper, to which is added protoxyde of tin. This last body tends to prevent the oxydation of the protoxyde of copper which would have the effect of colouring the glass green. A small addition of protoxyde of iron gives a scarlet red or flame colour. If the glass take a greenish tint a little bi-tartarate of potash will renew the colours by restoring the bi-oxyde of copper to the state of a protoxyde. The workman commences by taking on his "blowing-iron" a small quantity of red glass; he then plunges the tube into the white glass, of which he takes a much larger quantity, and he then blows it out according to the ordinary method of making "tables" of crown glass. This method was employed for the ancient glass of church windows; at the present day this glass is manufactured at Hoffnungsthal, in Silesia, by the Tyne Company in England, by Bontemps in France, and at Besançon.

The glass, as has been said, is cut up into coloured plates. The tints and half tints are applied by means of coloured enamels on one face or the other of the glass, which is exposed to heat, and the different pieces are joined by glaziers' lead according to the pattern or design. If the paintings be small, and designed to be viewed close, plated glass, and not glass coloured throughout its thickness, is employed. Parts of the coloured layer are removed at the requisite places, and on the white glass thus laid bare, the colours required for the painting are applied. In this way designs are obtained of which the colours differ altogether from the ground-colour. Instead of removing the coloured layer by mechanical means, it may be destroyed by fluoric acid.

The effect of the weather insensibly alters the colours of ancient paintings on glass.

Painting on glass properly so called, that is to say, the application of coloured enamels to uncoloured sheets of glass was little known to the ancient artists, and it is only in our own day that the progress of chemistry has advanced this art to any degree of perfection.

Painting on uncoloured glass was executed in 1800 by Dihl; it consists in tracing the same design on two sheets of plain glass, which are submitted to the action of fire, and then the faces on which the designs are drawn are laid one upon the other.

To fix by heat the colours on glass without altering its form, or fusing it, it is necessary to add vitreous matters, which are readily fusible, fluxes, which vary according to the nature of the colours.

Silicate of lead is employed with or without borax, minium and very fine sand are fused together, and different proportions of calcined silex and quartz. For instance, take

Quartz	.. ..	3 parts	or	Borax calcined	..	5 parts.
Minium	.. ..	9 „		Quartz	.. ..	3 „
Borax calcined	..	1½ „		Minium	.. ..	1 „

The quantity of flux required for each colour, so that it may have the required fusibility and clearness is very variable, the necessary proportion is in general three or four parts. All colours are not adapted for the same flux; the purple of gold, the blue of cobalt, require an alkaline flux; the minium injures these substances, while other deep colours are not injured by fluxes into which lead enters.

Some substances require to be vitrified with the flux proper to them, before they can be employed in painting, as the feeble heat to which they are subsequently subject is not sufficient to develop the colour properly. The deutoxyde of copper, and the yellows, blues and violets, are among these substances. With purple of gold and oxyde of iron on the contrary, great precautions are necessary to prevent the injury of the colour by too great heat. The coloured enamels when prepared are reduced to powder, and preserved from the action of moisture.

All kinds of glass are not suitable for painting. Excess of alkali is destructive; preference is therefore given to the hardest glass, which contains a great deal of silex, and which does not attract moisture, as the Bohemian glass for instance.

Before applying the colours with the brush, they are mixed on a palette with turpentine. When the painting is finished the colours are fixed by heat, an operation which requires great care and experience. Pots of fire-clay closed by a cover of the same substance are placed in a support of iron, so that they can be enveloped on all sides by the flames; the method adopted in France for cooling the glass is to put it in separate furnaces heated by charcoal. The plates of glass are laid one upon another on clay slabs, supported on props of the same material. The heat is judged of by trial-pieces, which are introduced with the rest of the glass into the furnace, and are withdrawn with a spatula. When the colours are well vitrified, the plates are put in the annealing oven and gradually cooled. It is necessary that this last operation should be conducted very gradually, to ensure the permanence of the colours.

The colour communicated to glass by the protoxyde of copper is, as has been observed, too intense to be employed alone, for it causes the "metal" to appear opaque of a deep brown. It is necessary for procuring a transparent red that the glass should be extremely thin. Consequently, the only means of getting red glass of a proper thickness is by covering plain glass by a thin layer of red. The plated glass has the advantage of allowing the partial removal of the red layer in order to obtain white figures or add other colours. The glass of the Middle Ages shows that this method was adopted by the ancients.

In order that, when the red and white glass are blown together, they may be well united and do not separate during cooling (as happened in some of Engelhardt's first experiments), the "metal" of both must be the same, or at least analogous. It is best to make the red a little weaker than the white; the latter must not contain any oxydising substance, which would injure the red colour.

Great care is required to avoid air bubbles in the glass. The red and white must be ready at the same time, in order to work together well. The beauty of the glass depends also materially on the skill of the workman, for it is easy to understand that the coloured glass is always thicker near the orifice of the blowing-iron than at a distance. It is on this account that the glass is seldom of a uniform colour, except in the middle of the plate: at the extremity of it the red layer is sometimes so thin that all trace of colour is lost. Dr. Engelhardt has preserved several ancient specimens, in which this gradation from a deep colour to a light one, has been made use of in a very happy manner to produce striking effects. After a certain degree of practice, the workman is able to obtain a tolerably uniform colour, and Dr. Engelhardt expects to effect this object completely in a glass manufactory where he has directed attention to this particular branch of the art.

It is sometimes necessary, when the glass has once been painted and the colours fixed by baking, to add a second coat of painting; and as it is then necessary that the glass should be again subjected to heat, the colouring matter must be rendered so fusible by an additional proportion of flux as to avoid all risk of fusing the colours first painted.—*Translated from the Revue Scientifique et Industrielle.*

CLERESTORIES IN MODERN CHURCHES.

Christ Church, Plymouth.

Sir,—I am really most reluctant to intrude myself again upon your pages; the more so, as "Candidus" has so kindly and (of course, as *I* think) so ably defended the principles on which I have acted. The answer, however, which you have made to "Candidus" seems to require from me a word or two in explanation. In the first place, Christ Church, Plymouth, is *not* lighted by "clerestories *only*." There are windows at the east ends of the aisles on the gallery floor, besides the two great east and west windows, which literally *do* make the main body of the interior as "cheerful as the day;" and in the darkest seats beneath the galleries, on a gloomy day, you can see perfectly well. There is *no* part "useless" or even "inconvenient," "by its darkness." The body of the church is so wide, and the gallery recesses so comparatively shallow, that the "defect" which you say "*must* exist" does *not* exist. Though a positive *sun-beam* cannot "shine round a corner," it is equally certain that where there is a great central reservoir (if I may use the expression) of daylight, it will expand its illumination even into corners which the sun's immediate rays can never reach. Again, "the extent of unbroken surface of the north and south walls" is not so great as you seem to imagine. There are recesses for seats where, under other circumstances, there would have been windows; and these (had our means allowed it) might have been rendered highly ornate. At all events, here are admirable localities for mural monuments.

You are, likewise, under a misconception as to the reference made by "Candidus" to the octagon of Ely Cathedral. The "lower windows," as you term them, are only "lower" than the *lantern*. They are the *clerestory* *windows* of the *octagon*, above the arches opening into the aisles, and ranging with the clerestory of the nave.

In assuming it to be an "essential principle of Pointed architecture that the north and south walls of a church should have windows, because you find this to have been universally the case in ancient examples of the art practised by its inventors," you, in fact, deny the applicability of Pointed architecture to any church that is not insulated; or, in other words, you declare that no circumstances can warrant the construction of a church in immediate contact with other buildings on either hand. This may, or may not be. All I desire of my critics is a fair consideration of the *conditions* under which my church has been built. They were imperatively these:—*the Gothic style*, and *no north or south windows;* the latter resulting from the economy which required a *maximum* building on a *minimum* space, and therefore precluded any north or south area. The question was, whether a certain number of Christians should remain without church sitting-room, or whether a church without north or south windows (in the Gothic style) should be built?

I shrunk not from the attempt to reconcile the demands of my employers with the limits of my means; and considered, that no "essential principle" of architecture (be it "Pointed" or otherwise) would be compromised by the *modification* of ancient example to modern purposes. I did as I conceived the old architects would have done under the different necessities of protestant worship and other peculiar circumstances of means and situation; and I am not aware that any, who have *seen* the result of my endeavours, have pronounced them unsuccessful.

I am, Sir,

Yours truly,

George Wightwick.

[The difference between Mr. Wightwick's opinion and our own respecting the subject of the letter which he unnecessarily apologises for sending, is, probably, less than he himself imagines. Where the question arises, as he has stated it, "whether a certain number of Christians should remain without church sitting room, or whether a church without north or south windows (in the Gothic style) should be built," we must answer at once that the attainment of the main purpose of the building should be preferred to all considerations of architectural beauty.

It is conceded, however, by the phrase "modification of ancient example," that the mode of construction suggested is modern. The only question between Mr. Wightwick and ourselves is, whether the ancient architects could have been induced to adopt this mode. We think not, and will give the reasons of our opinion consecutively.

I. Ancient precedent is universally in favour of this opinion. In *all* ancient churches, *without one single exception*, the aisle or nave windows are an essential part of the edifice. We do not mean to strain the argument of precedent beyond its proper limit, or to advocate the imitation of the practice of our forefathers without examining the correctness of their principles. But the plea of precedent is at least valuable thus far—that the universality of it indicates something more than the uniformity of mere routine. It seems obvious that if the mediæval architects, under whatever different circumstances they constructed churches, whether isolated in villages, or among the crowded buildings of large towns, or within the walls of fortresses, colleges, or abbeys,—whether the site were on a plain or on the precipitous declivities of a feudal fastness,—under conditions the most varied and frequently the most difficult, adhered to the principle of building nave windows, we have at least a presumptive proof that the inventors of Pointed architecture, who may be supposed best acquainted with its essential nature, considered this principle of paramount importance.

It is to be remembered that the ancient architects frequently built churches under the same difficulties, arising from the contiguity of secular buildings, which embarrass modern architects. In the old cities of Normandy and Flanders the careful observer will notice cases of churches to which large additions had been made after the site was closely hemmed in by other edifices; and it is frequently very instructive to observe the skilful means adopted to procure access of light to the lower part of the added portions of the building.

II. The light of the clerestories was always subordinate to that of the aisles until Pointed architecture began to decline. In Early English and Decorated architecture, clerestories are not nearly so large as in Perpendicular buildings. In the former styles the clerestory is in by far the greatest number of examples omitted altogether; and where it exists, the windows are always small, and the light from them greatly subdued. In churches these windows are trefoils or quatrefoils or other single-light apertures: clerestory windows of more than one light are confined to cathedrals or very large churches. In the Perpendicular architecture, however, especially in the latter and worst part of it, the fatal principle of enlarging the clerestories was first introduced, and became a powerful cause of the debasement of Christian architecture. To the very last, however, the construction of nave windows was universally retained, even when the art exhibited that sure and certain mark of decay—the substitution of elaborate details for simplicity and excellence of design.

The preceding arguments are of the nature of historical considerations. We wish, however, to guard ourselves against the supposition that we over-estimate the value of precedent. We trust that we shall never be accused of irreverence for antiquity; but, at the same time, it is mere pedantry to affect ancient rules which have no intrinsic merit to recommend them. Precedent always furnishes *presumptive* evidence, but there are three causes from which it may become valueless. First,—an ancient practice may have originated in prejudice or accident and not in fixed principles. Secondly,—the fixed principles which influenced the ancients may be proved, by subsequent knowledge, to be erroneous or insufficient. And lastly,—principles which were perfectly sufficient when first acted upon, may, by time and change of circumstances, become obsolete. It is therefore necessary, for the completeness of our argument, to show that none of these causes operate in the present case to destroy the value of the precedent. We proceed, therefore, to the arguments derived from general considerations of the nature of Pointed architecture.

III. The clerestory admits light in that part of the church which appears most beautiful by a subdued light. The solemnity then of the appearance of a church is derived in a great measure from the comparative obscurity of its roofs. The dark shadowy roofs of Pointed architecture have been favorite subjects of admiration with those who are excellent judges of general architectural effects—the poets. In questions like these, one example is worth a folio of dissertation, and if those who are really anxious to get at the truth in this matter will take the trouble to observe the difference between the mode of lighting the interior of the nave of Westminster Abbey and Henry VIIth's Chapel, they will have no difficulty in arriving at a conclusion. In the former case, the great body of light (notwithstanding that much of it is unhappily obstructed by preposterous monuments) comes from the aisles, and produces the most beautiful effect by the shadows of the piers and arches. The light of the clerestory is comparatively small, and must have been still less when the windows were filled with stained glass. Let the reader, when he has carefully observed the effect of the light in the nave, especially at the western end of it, proceed to Henry the Seventh's Chapel—a building belonging to the very last period of which the Pointed architecture continues to claim our respect. In this chapel he will find enormous clerestory windows, admitting a flood of light near the roof. The lower windows give but little light, and that little is almost entirely obstructed by the stalls. Here, therefore, the observer has one of the best instances which ancient churches afford of the effect of light admitted by clerestories. We have never heard any difference of opinion among unprejudiced persons as to the *solemnity* of this effect. It is not solemn—it is scenic—theatrical—the glare thrown from the upper part of a stage when the foot-lights are lowered. Compared with the effect of the nave of the Abbey, there cannot be a doubt which exhibits the "dim religious light" of a Christian edifice. The gorgeous multiplication of ornaments which profusely decorate Henry the Seventh's Chapel dazzles the eye, but produces nothing like a *solemn* impression, and the judicious observer goes away satisfied that the design and general arrangement of this structure is incapable of that stately grandeur which imposes a feeling of awe and reverence. Westminster Abbey is by no means the most favourable instance which we could have selected, but it was the most familiar. But imagine some of the more magnificent cathedrals of the continent lighted by the clerestories alone—Antwerp, or that of Cologne, or Rouen! Suppose, if it be possible, the dim obscure roofs of these glorious edifices suddenly illuminated by a flood of light;—where would be the solemnity of the "long-drawn aisles" then? Suppose the windows of these aisles darkened and every shadow reversed,—will it be denied that the effect would be absolutely hideous? Or if it be objected that the question in dispute refers to a church and not to a cathedral, we will cite the well-known instance of Great St. Mary's Church, at Cambridge, where the dazzling light of the clerestory is not only destructive of all solemn effect, but actually painful to the eye by its violent contrast with the comparative darkness of the aisles.

IV. By the undue enlargement of the clerestory, the piers and arches become subordinate parts of the structure. This result is produced not so much by the actual diminution of the size of these members as by the prominence given to the clerestory by the light proceeding from it. Now the consequence of this is, a violation of the rules of "apparent construction," for the greatest weight to be supported being that of the nave-roof, the arches and piers should be treated as of primary importance: the architectural effect of them is destroyed directly they become subordinate, and accordingly in the best churches the piers of the nave have great strength, and the weight of the roof appears directly imposed upon them. Where, however, the wall above the arches is perforated by numerous windows (sometimes so numerous as to give this part the appearance of a huge lanthorn), the roof never seems adequately supported: there is an appearance of instability produced, which is directly opposed to the canons of architecture. And this instability is not always merely apparent. It is frequently a matter of observation that the walls of the clerestory, where they have been weakened by the size of the perforations, are thrust outwards by the pressure of the roof. This deviation from the perpendicular is especially observable in cases where a Perpendicular clerestory is a subsequent addition to a Decorated or earlier church.

V. A church is not a mere façade. That word *façade* is Italian in its origin, and both the word and thing signified belong exclusively to Italian architecture. The Christian architects viewed their churches not as mere surfaces or fronts, but as possessing the dimensions of length, breadth, and height. The *superficial* style of architecture is a modern invention, doubtless derived from that habit of *making up elevations* on the Italian principle which characterized the last century.

Of the reversal of the shadows where the light is obtained from a clerestory *exclusively*, it is not necessary to speak at large, because we have elsewhere spoken of it. We may observe, however, that in the mouldings of nave-arches and the deep undercut capitals of pillars the shadows must be exactly reversed when the light is obtained from a clerestory, instead of the aisles: in the one case these shadows are thrown downwards—in the other upwards. Consequently the architect, if he have a due sense of constructive propriety, will never dream of using ancient mouldings in churches built on the new plan—he must devise new mouldings suited to the novel disposition of the light. This point is not one of speculation but observation, as any one familiar with ancient mediæval mouldings may satisfy himself by examining the result of introducing them into some of the new London churches, windowless aisles.

The breaking the continuous surface of the north and south wall by recesses instead of windows, is an expedient which by no means removes the objections here assigned. We have, in a previous number, guarded ourselves against the conclusion that churches are necessarily to be isolated. There are many cases where chapter-houses, cloisters, &c. abut on churches without marring their architecture. If however we be asked whether a church built in the line of a street, between adjacent houses, and only distinguished from them by having its gable instead of its parapet turned towards the street, and by the display of a few stock-in-trade Gothic ornaments, satisfies the essential principles of mediæval architecture, we answer emphatically and unhesitatingly—No. By no means—if the laws of style are to be interpreted by the spirit instead of the letter—by the general artistic effect of a design, and not by minute resemblances of detail.

We know that architects have much to contend with in the injudicious wishes and erroneous taste of those who employ them; but we are also convinced that they may frequently get over these difficulties by firmness, and by explaining the reasons which fortify their own opinions.

Of course when an architect is told to build a *maximum* church on a given area, or a church of given cubic contents on a *minimum* area, the question becomes one of simple geometry—all idea of architectural propriety must be given up. In less hopeless cases, however, we would venture to recommend the architect to leave a little space, if only of two or three feet, between the walls of the church and those of the adjacent houses,—to provide at least enough space for the construction of buttresses. It will require some additional expense to render the north and south walls uniform in architecture with the rest of the church, and the architect will have to practise some self denial, since he will not have so much money to expend on the more conspicuous western end. But this self denial will be well rewarded, for though there will not be so much to attract the eyes of mere lovers of show, the homage paid to the principles of pure taste will claim the admiration of the judicious observer, "the censure of which one must, in your allowance, outweigh a whole theatre of others."

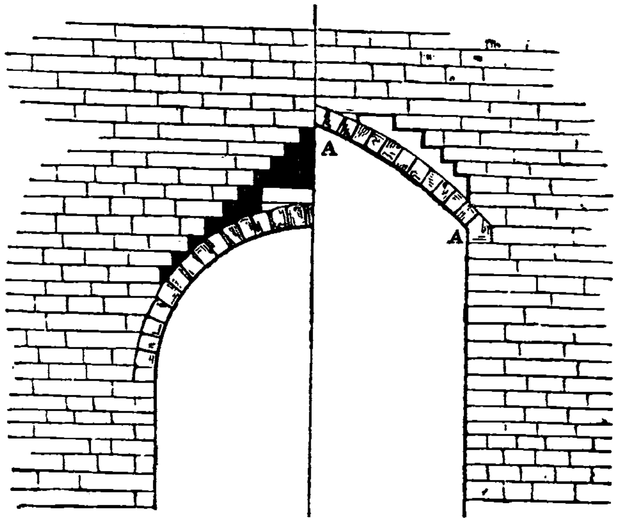
Of course this advice is given on the most unfavourable supposition, namely, that there are not funds to purchase the adjacent buildings. In this case it may be well left to the munificence and good-feeling of future benefactors to contribute the means of removing these obstructions, and displaying in all its dimensions, the edifice which then, and not till then, will exhibit the character of a Christian Church.]

THEORY OF THE ARCH.

Sir—In our last letter we endeavoured to show that your review of our pamphlet was written under a misconception of the principles therein advanced, and hence the wholesale condemnation with which you were courteous enough to favour us.

You have challenged us to show where the standard writers on the theory of the arch have failed in their reasoning. We should consider it presumptuous to entertain any doubt of the accuracy of the statements of Professor Moseley, neither does his theory of the arch, and the method by which he arrives at the line of resistance and the line of pressure, militate against the observations which we have ventured to bring forward.

We maintain that the voussoirs of an arch, of any form, have only to support that portion of the superstructure where the corbelling ceases to



exist (represented by the shaded lines in the accompanying diagram). Now, if the "two-centred pointed arch"—not the plate bond, which you have erroneously put forward as our proposition,—shown at A, A, is substituted for the semicircular, segmental, or elliptical, is it not manifest that there is greater strength obtained, with less amount of material? The beds of the voussoirs being nearly parallel, and the key stone of the arch being the only portion at all affected (in a downward direction) by the superincumbent weight, it appears to us to possess advantages co-equal with the "merit of novelty."

We do not consider it worth while to occupy your pages with any remarks respecting the title of our tract; if we have demonstrated that a stronger arch at less cost is obtained by our method of construction, we shall consider our labours amply repaid.

We are, Sir,
Your obedient servants,

Blair and Phillips.

ARCHITECTURAL COMPETITION.

Sir—The recent award of premiums of competitors for the Leeds Industrial Schools, affords another source of *encouragement* to young architects, and is too good an example of what professional men have to contend with, to pass unnoticed.

The Committee was composed of one respectable innkeeper, a fourth-rate manufacturer, a maltster, a drug dealer, a house painter, a leather dealer, a grocer, and an apothecary. The Plans were hung up for the private inspection of the committee and friends by a joiner, who gave the names of the competitors to the parties, but to appear decent, they called in a reputable architect, from a neighbouring town, to decide upon the merits of the designs, and on his decision this Committee professed to act.

Among the competitors were some four or five architects (one of whom took care, with all due *northern foresight*, to describe by letter his *pertickler* plans to his friends on the Committee, lest they perchance might favour those of *older* and better rivals); another competitor was a joiner, preacher, and conventicle builder; another, a pot-house keeper, who began his career as a joiner, and perfected himself as a toll clerk of a market-house.

The Judge made a just award, upon which the committee did *not* act, but contrary to all reasonable expectation, they gave the first premium to their friend whose *brandy-and-water* and *pennyworths of tobacco* had oft regaled the majority after closing their shops.

Much more might be said, but this suffices to show the state of art in this great manufacturing place, and how hopeless is the chance of any young or old architect to erect a public building here, unless expressly commissioned by some of the few men of education and taste who remain to us of the *ancien regime*.

I remain, Sir,
Your obedient servant,

Leeds, April 18, 1846. VIATOR.

REGISTER OF NEW PATENTS.

If additional information be required respecting any patent, it may be obtained at the office of this Journal.

MOTIVE POWER.

DAVID WILKINSON, of Potters Bury, near Stoney Stratford, Gent., for "*improvements in obtaining motive power.*"—Granted October 10, 1845; Enrolled April 9, 1846.

This invention consists in a mode of combining heated air with steam, instead of using air or steam separately. In carrying out this invention the patentee proposes to apply an air pump of about half the cubic contents of the cylinder, by means of which air is to be forced through tubes or other suitable apparatus, such apparatus being heated externally, so that the air may become highly heated, which is afterwards admitted into the steam boilers or generators, that the heated air may combine with the steam and go together into the working cylinder of the engine. This invention is more particularly intended for high pressure engines, notwithstanding, the patentee states the same is equally applicable to low pressure or condensing engines.

The claim is for forcing air through pipes or other suitable heated surfaces and then mixing the same with steam, and working the steam and heated air conjointly.

SLIDE VALVES OF LOCOMOTIVE ENGINES.

ROBERT BEWICK LONGRIDGE, of the Bedlington Iron Works, near Morpeth, Northumberland, for "*an improved locomotive engine.*"—Granted January 13; Enrolled March 13, 1846.

This invention for improvements in locomotive engines relates to the slide valves and mode of working the same. The accompanying figure shews a

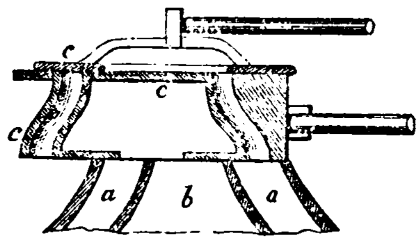


Fig. 1.

transverse section of the slides and steam ports leading to the cylinder. *a a* are the induction ports leading to the cylinder; *b* is the eduction port; *c c* is a slide valve for opening and closing the ports in the cylinder, and is worked by an arrangement of levers and excentric, which latter is capable of being moved upon the shaft say 30 degrees on each side the centre of the crank, for backward and forward movement of the engine. The induction ports of the valve pass through to the back thereof, at which place there is a second slide *c'* for cutting off the steam at any required part of the stroke. This latter valve or slide is worked by an excentric, keyed fast on the shaft,

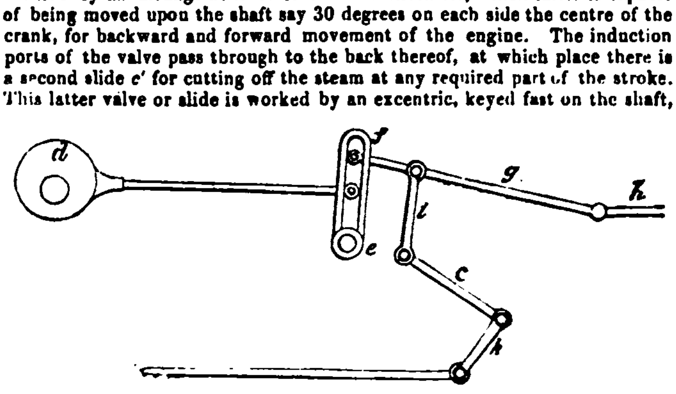


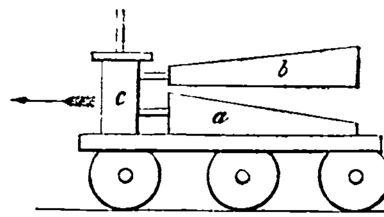
Fig. 2.

and an arrangement of levers shown at fig. 2. *d* is the excentric rod, the outer end of which is connected to a lever keyed on the weigh shaft *e*; upon this shaft is keyed a slotted lever *f*, which receives a stud attached to the end of a link *g*; the opposite end of the link *g* is attached to the valve rod *h*, so that by raising or depressing the stud in the slotted lever *f*, the amount of motion imparted to the valve rod *h* and valve or slide *c'* can be varied at pleasure. The end of the link *g* is raised or depressed in the slot by means of a rod *i*, attached to the end of a bell-cranked lever *k*; to the opposite end is attached a rod *l*, actuated by a lever placed near the engine-driver. Another improvement consists in heating the water supplied by the feed pumps previous to entering the boiler. For this purpose the inventor proposes that the water, after leaving the feed pumps and before entering the boiler, shall pass through a chamber or series of pipes exposed to the action of heated vapours, which pass through the tubes into the smoke box, so that the water may become highly heated before entering the boiler.

LOCOMOTIVE ENGINES.

HENRY SAMUEL RAYNER, of Ripley, Derby, Gent., for "*certain improvements in locomotive engines.*"—Granted September 4, 1845; Enrolled March 4, 1846.

The object of the inventor is to construct a locomotive engine, which is to be propelled by the pressure of the atmosphere acting upon the exterior surface of a vessel or vessels exhausted of air. The annexed diagram shows a side elevation of Mr. Rayner's locomotive, which may be termed a perpetual locomotive, being of that class of machines when once started will continue its course so long as the parts of the apparatus will hold together! *a* represents a rectangular or oblong vessel of a wedge-shape form mounted upon



the carriage framing; above this vessel is fixed another (marked *b*) of the same construction, but in a reverse position; the object of reversing the two vessels being for the backward and forward movement of the apparatus. Each of these vessels are made hollow and perfectly air-tight, and are connected, by means of a pipe, with an air-pump *c*, also fixed upon the framing of the carriage. Now, in order to start the locomotive, Mr. Rayner gravely proposes to exhaust one of the two vessels *a* or *b*, when the locomotive will be propelled either backward or forward as may be required. For the inventor states, if the vessel *b* be exhausted of air, a certain amount of pressure will be exerted on the whole of its exterior surface; that is to say, there would be a vertical pressure on the upper or inclined surface, which the ingenious Mr. Rayner supposes would propel the locomotive; in order therefore to counteract this propelling power, he proposes to have the "wheels, rails, and axles" at an angle, so that the locomotive under such circumstances would remain motionless. He then states that the sides of the vessels being equal to one another, the pressure would be equal; that is to say, the pressure on one side of the vessel would be counteracted by that of the other. Now, the pressure on the under surface, the inventor states, is counteracted by the *gravity* of the carriage (this would not have been a bad idea for Hanson's ærial machine). Again, the pressure on the ends of the vessel is also the same per square inch as the other parts of the vessel; but one of the ends is double the area of the other, consequently, there will be double the pressure on the larger end of the vessel *b* when exhausted, tending to propel the carriage in the direction of the arrow; and in order to reverse the motion of the locomotive, it will only be necessary to exhaust, by means of the air-pump *c*, the vessel *a* in place of the vessel *b*. In conclusion, it would perhaps not be out of place to recommend the inventor to pay a little more attention to the study of pneumatics before he attempts to bring his invention before the public.

PROPELLING POWER.

JOHN LAKE, of Apsley, in the county of Herts, civil engineer, for "*certain improvements in propelling.*"—Granted October 9, 1845; Enrolled April 9, 1846.

This invention consists in a peculiar mode of propelling carriages on railways and common roads, and also barges or boats on rivers and canals. In carrying out this invention it is proposed to lay between the rails a continuous pipe, having a longitudinal slit or opening similar to those employed on atmospheric railways, as will be seen on referring to fig. 1, which represents a longitudinal section of a portion of a tube showing the other arrangements necessary for propelling a train of carriages upon a line of railway, between the rails of which is placed the tube *a*, and continued throughout the whole length of the line. Within this tube there are two pistons *b b*, connected together by means of a pipe *c* with a stop-cock *d*;

this pipe is firmly attached to a vertical arm that passes through the longitudinal opening and attached to the leading or driving carriage of the

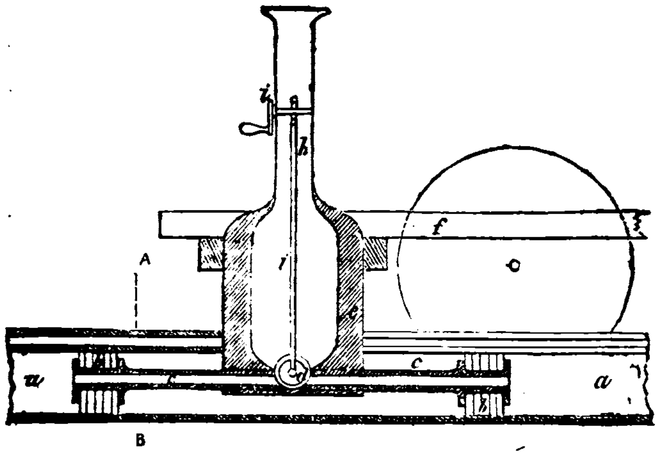


Fig. 1.

train, a portion of which is marked with the letter *f*. Fig. 2 represents a transverse section of the apparatus taken through the line A B of fig. 1, in which is shown the mode of closing the longitudinal opening by means of a valve *g* sliding edgeways into a groove or recess formed in the upper part of the tube. The operation is as follows:—At certain intervals along the line

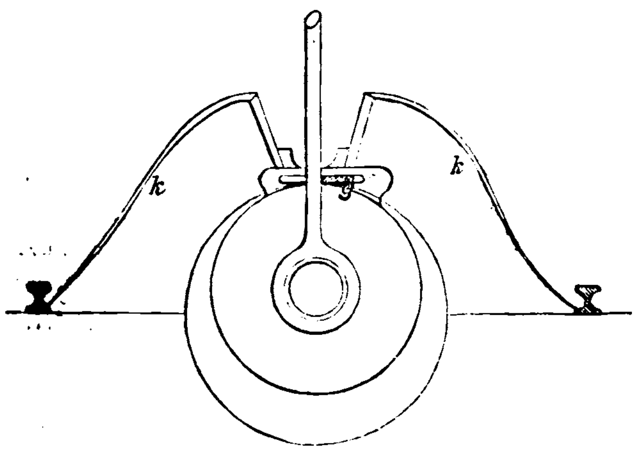


Fig. 2.

are to be erected steam boilers; and in order to propel the carriages, steam is to be admitted into the tube *a a* throughout the whole length, for the purpose of warming the tube and driving out the air. The ends of the tube and longitudinal opening being closed, a communication is to be formed with the tube and a condenser, similar to those employed in steam engines, for the purpose of condensing the steam, leaving the pipe empty or nearly so; when this is done the piston *d d* is brought near to the opening leading from the boiler, when a fresh supply of steam is admitted, which will have the effect of propelling the piston and train of carriages along the line. The specification states that the condenser may be dispensed with by opening the cock *d*, so as to let the steam first introduced into the pipe pass up the funnel *h* for the purpose of driving out the air. *i i* is an arrangement of levers for opening the valve *d*. In place of having stationary boilers, the inventor proposes to have an ordinary locomotive boiler, and instead of the steam working the engines as heretofore, such steam is allowed to pass through the pipe *c c* into the main, either from behind or in front, depending upon the direction in which the carriage or train is to be propelled. In descending inclines, the inventor proposes to fill the tube with steam, which will have the effect of a break, the motion of the carriage being regulated by opening the valve *d* so as to allow the steam to escape from the main *a a* through the funnel into the atmosphere. *k k* (fig. 2) represents a covering for the pipe, composed of felt, straw, sawdust, or other bad conductor of heat.

White Gravel.—Upwards of 7,000 tons of white gravel have been shipped from this city to London since the 15th of September last. It is taken from the beach at Long Island, and used to beautify the parks and gardens of London.—*New York paper.*

A NEW GONIOMETER AND CRYSTALLONOME.

At a recent meeting of the Chemical Society, Dr. Leeson read a paper "*On crystallography, with a description of a goniometer and crystallonome, or instrument for studying crystals, in reference to their gubernatorial axes.*" The author commenced by observing that discriminative chemical researches have not received that assistance from crystallography which might reasonably be expected from the natural distinction of form peculiar to various different substances.

The particular design of the author's present paper was to introduce greater facility and simplicity in the classification and determination of crystalline forms, both by improved methods of observation, and also by a system of classification founded on the three gubernatorial axes, for the happy discovery of which we are indebted to Weiss, by whom, however, as well as by others who have succeeded him, systems have been proposed by no means realising that simplicity and perfection of which the fundamental principle is believed to be susceptible. To prove that the nomenclature and classification of the different authors were both confused and complicated, various tables were referred to, showing the systems respectively adopted by them. By referring to which it was apparent that different authors used the same terms for totally different fundamental forms; and also that by many of them terms were employed which, having reference simply to the *number* of planes bounding a given system, were, in fact, as subsequently demonstrated, applicable to every class and order, and therefore not *discriminative* of any one in particular. Any one who may have carefully examined the first crystals depositing from solutions of different substances, will be struck by the general prevalence of the prismatic or hexahedral form, or of some modification thereof; at the same time, he will observe great variety in the *number* of planes bounding many of the crystals. Under the microscope he will not only be struck by the general prevalence of parallelograms, or sections of the prismatic forms, as well as hexagons, triangles, and other sections, resulting from hemihedral modifications, but also by the *primâ facie* similarity of the sectional forms presented by totally different substances. It is in the discrimination of these forms that the principles of classification now about to be proposed, and the goniometer subsequently described, are peculiarly applicable.

Before describing the system itself, the author requested to explain an instrument which he exhibited, and stated he had contrived some years ago, for the purpose of studying the relative character of crystals derived from different positions and lengths of the three gubernatorial axes, and for which instrument he requested to be allowed to propose the name crystallonome. The author showed, with that instrument, that whatever be the length and relative position or inclination of the three axes, a prism or hexahedron must necessarily result from a set of planes terminating the extremities of the respective axes, such planes terminating one axis, and being parallel to the other two axes. These planes were represented by a contrivance for attaching pieces of stiff paper or card-board to the extremities of the axes. The author then showed that an octahedron must necessarily result in every case from a set of planes cutting all three axes, and which octahedron might easily be built up and represented by threads connecting the extremities of all the axes. The construction of other forms was also demonstrated.

The crystallonome, although constructed with only three zones placed at right angles to each other, is nevertheless capable of showing the position of the axes in every class, even where all the axes are oblique; this was illustrated by the instrument itself. It was also shown, that whatever be the class and order of a crystal, there are always two zones in which all three axes will be found. It having been already stated, that the three gubernatorial axes form the basis of the proposed system, it will be evident that the discriminative principles of the system must be dependent on the position and length of the respective axes. Since the relative position of the axes occasions the greatest difference in the appearance and character of a crystal, it seems natural to take that as determining the class; and we shall find that as regards this distinctive character, there are but three classes to which the variation of position can give origin, viz.:—1, where all the axes are situated at right angles to each other; 2, in which one axis is at right angles to the other two, which are obliquely placed as regards each other, one rectangular axis and two oblique, being, in fact, the same as though we represented it as two rectangular axes and one oblique; 3, in which all the axes are oblique to each other.

We have thus three classes, which we term respectively:—1, rectangular; 2, right oblique; 3, oblique; and these we again subdivide into three orders, dependent on the relative length of the axes, viz.:—1, all the axes equal; 2, two axes only equal, the third being longer or shorter than the other two; 3, all the axes of different lengths. These orders we term—1, equiaxial; 2, binequiaxial; 3, inequiaxial.

With these three classes and three orders we obtain nine distinct crystalline bases, which, the author trusts, will be found easy to remember and simple to distinguish. Generally speaking, few substances will be found to crystallise in forms belonging to distinct classes or orders. Without, however, passing any opinion on the subject of dimorphism, the author showed, by reference to the native crystals of sulphur, and also those obtained by fusion, that, according to the system now proposed, sulphur cannot be considered as dimorphous, the native crystals being, in fact, modifications of the octahedrons, or the rectangular inequiaxial system; whilst those of fusion are prisms or hexahedrons belonging to the same system. Both were exhibited to the meeting, and the goniometer, subsequently described, applied to the measurement of the angles of the crystals of fusion. Whilst a chemical substance usually crystallizes in forms pertaining to the same class and order, it may nevertheless, as has been already shown, assume a great variety of forms, if reference be had only to the number of bounding planes; and these forms constitute what may be termed the genera of the author's system, which were shown by reference to diagrams, as also the symbolic notation recommended by the author.

The author concluded by exhibiting his goniometer, consisting of a double refracting prism, placed in a vernier revolving round a graduated circle, and applicable either to the microscope or to crystals placed on any convenient stand. He stated, that in most cases of crystallisation, particularly under the microscope, some crystals will be observed presenting the prismatic or hexahedral form; and knowing that the gubernatorial axes of any prism must terminate in the centre of the sides of that prism, we are at once directed to the position and length of the axes in any given crystal; whilst, by examining the angles formed by the sides of the parallelogram constituting the section of the prism with the goniometer, we may determine the inclination of the several axes. In all natural octahedrons formed by inaxial planes, the axes will be found, as shown by the crystallonome, by taking the points where four planes meet. Although octahedrons may be mathematically formed by biaxial planes—that is, by bending in the sides of the prism—it is believed that such octahedrons do not occur in nature, as it would contradict the general laws of symmetry, inasmuch as that, whilst the perpendicular axis terminated at the meeting of four planes, the middle and transverse axis would be situated in the centre of an edge bounding two planes—a state of things that could not certainly occur in the regular system; the general condition of natural symmetry being, that whatever disposition takes place at any one extremity of an axis of equal length, the same will take place at its other extremity, and also at the extremities of every other axis of equal length.

REVIEWS.

Parish Churches, *being Perspective Views of English Ecclesiastical Structures, accompanied by Plans, drawn to a uniform scale, and letterpress descriptions.* By R. and J. A. Brandon, Architects. Bell, Fleet-street, 1846. No. 1, 8vo., pp. 12; fourteen lithographic plates.

Messrs. Brandon are already favourably known to our readers as authors of the *Analysis of Gothick Architecture*, reviewed in this Journal for August 1844. The publication now before us is the first of a series intended to illustrate "such Churches as from their beauty of design and peculiar fitness for the sacred purpose for which they were reared, seem worthy of being adopted as models by those engaged in Church building." The principal distinction between the present work and the "Analysis," is, that while the latter was exclusively confined to the exemplification of architectural details, the new series gives views of entire buildings only.

Our old English Churches are so beautiful, and contain such treasures of architectural science, that we naturally commence the examination of any work, which professes to contribute to our knowledge of them, with a favourable prepossession. We cannot suggest a work which we should study with greater personal gratification than one which gave a *comprehensive, systematic, and minute* record of all that is valuable in our national church architecture. Such a work, however, to be satisfactory, must be conducted with liberal and extended views; it should be a very cyclopædia in which nothing is left out that deserves a place in it. The chief value, or to speak more truly, almost the only value of such a publication would be its *completeness*. Of course we do not mean that the work should be a confused mass of facts—a collection of knowledge so ill assorted and so crammed and crowded together, as to become, like certain modern cyclopædias, that we wot of, absolutely unintelligible. But we repeat a deliberately formed conviction that the *most* valuable contribution to architectural literature which could now be made, would be a digested and complete pandect of church architecture—not concocted hastily as a publisher's speculation to meet a transitory mania for old churches, but arranged, slowly and carefully, from a mass of information collected by pains-taking and unwearied research.

The work before us certainly does not reach this mark. The plan of it, as far as we can see, does not make any pretensions to system, and is by no means comprehensive enough. Each number of the series is to contain eight perspective views of churches, selected at random from different counties and in different styles, and the work will be completed in twelve parts: so that, altogether, we shall have ninety-six churches delineated. But what are these among so many? If Messrs. Brandon would multiply the proposed number by ten or twenty, their undertaking might assume an importance commensurate with the object in view. Not, indeed, but that the work is in many respects a valuable contribution; and if we speak of it in terms of qualified praise, it is on the score of sins of omission, not commission. The views here given are not absolutely faulty, but there are numerous drawing-books, published as first lessons in pencil drawing which frequently contain sketches which are quite as good. The letter-press descriptions, again, are not nearly copious enough, and this defect might be remedied the more easily as the authors state that they intend to visit personally every church illustrated. In the number before us, the description of each church is comprised, on the average, in thirty lines.

One other point to which we must allude is important. The authors state their intention of selecting churches which seem "worthy of being adopted as *models*." We hope they will give up this part of their plan. Nothing can be more fatal to the progress of architecture than the modern idea of model churches. Let us study the *principles* and the forms devised by our ancestors, and their modes of combining them with the zeal and reverence of learners; but let us not grow mere copyists of ancient churches. This contentment with mere reproduction marks the lowest ebb of artistic feeling—the very last stage of architectural degeneracy. The vilest modern plaster-gothic travestie is better than absolute copying; these abortions, hideous as they are, mark at least a desire to regain something of the glorious art lost among us during the Reformation; but mere mechanical imitation argues absolute hopelessness—the indolence of despair—that we have given up all endeavour to recover the ancient excellence of our national architecture, because satisfied by experience of the absolute futility of the attempt.

Besides, even supposing the copy to be fairly made, and to be a faithful transcript of the original, there are ten chances to one, that some local circumstance, an irregularity in the site, the proximity of secular buildings, or even local customs and requirements, may render it inconvenient or unfit for its purpose. Our ancestors did not design churches and stick them down *anywhere*: on the contrary, they examined the site of the new building, the nature of the soil, the particular wants intended to be supplied, the *character of the surrounding scenery*, and a thousand accidental local circumstances, before projecting the form to be adopted. A church built on a hill top would, according to their exquisite feeling of propriety, require different treatment to a church on a hill side or in a valley. A church hemmed in by woodland scenery would of necessity be different from one built on a wide open plain. Modern practice does not recognise these subtle distinctions. *We* get up a dozen or score of designs for new churches, send them to a picture exhibition to be duly admired by fashionable visitors, and duly be-paragraphed in the newspapers, and are fully prepared to execute our plans (any or all of them,) in any given spot of this island, or if need be, in the most distant quarter of the globe. They are building now, in Calcutta, a cathedral with roofs as sloping and windows as numerous and large as those suited for a similar edifice in latitude 51°.

Even if we conceded the principle of adopting architectural models, we certainly ought not to take those selected by Messrs. Brandon. A model church ought, at least, to have a uniformity of plan—a consistency of design in it. The examples before us show, on the contrary, such a remarkable diversity of style, that we might almost suppose them selected for that very peculiarity. The first church delineated, *Little Casterton, Rutlandshire*, is Early English, with Norman piers and arches, Perpendicular clerestory, and a Decorated piscina; the second, *Apston Church*, in the same county, is Perpendicular externally, with the exception of some Decorated windows; in the interior, the arches on the north side of the nave are circular. *Duddington, Northamptonshire*, the third specimen, is in the transition from Norman to Early English, with a north aisle Norman, and a Perpendicular clerestory. *Herne Church, Kent*, is apparently the most unmixed in style, being almost entirely early Decorated, with, however, some Perpendicular details. *Brampton Church, Northamptonshire*, the last example, has an Early English chancel and a Perpendicular nave; this church, by the by, has (on paper at least) somewhat too much of the prim pert look of modern Gothic.

We hope that as the work proceeds, the plan of it will be extended, and that all idea of furnishing models will be abandoned. It certainly would be preposterous to re-construct buildings which, like those here pourtrayed, are the growth of successive ages. The authors of the present work are fully capable of contributing largely to the science of mediæval architecture, and we trust will greatly extend the limits which they have assigned to their undertaking.

Reply to "Observations" of the Great Western Railway Company on the Report of the Gauge Commissioners. Vacher, Parliament-street. 1846. 8vo.; pp. 75.

This rather long "reply" is in the form of a pamphlet, which, if we mistake not, claims Mr. Wyndham Harding for its author. The style possesses the clearness, and the views are expressed with the moderation, by which Mr. Harding's dissertations on the gauge controversy have been characterised. Without involving ourselves in the discussion, we cannot help expressing an opinion that those who have read the "Observations" of the Great Western Railway Company ought certainly to examine the present pamphlet, which meets each argument consecutively, and treats the general question with great perspicuity. We wish, however, more had been said about the Intermediate Gauge. There are many competent persons—Messrs. Bury, Vignoles, and Cubitt, Col. Landmann, and General Pasley are among the number—who think the broad gauge too broad, and the narrow gauge too narrow. In the present pamphlet this opinion is dismissed in twelve lines; in the Commissioners' Report scarcely more space is occupied with it, and the view there taken is supported by very inadequate and inconclusive arguments.

Tables and Rules for facilitating the Calculation of Earthwork, &c., of Railways, Roads, and Canals. Also essays on the prismoidal formula, and on the power required upon inclined planes. By J. B. Huntington, C.E. Weale, Holborn, 1846. 12mo. pp. 286.

The object of this work in some measure resembles that of a smaller one by Mr. Hughes, reviewed in the March number of this Journal. The present treatise, however, embraces several subjects in addition to the calculation of earthworks. Tables are given for the calculation of the areas of slopes, the offsets and radii of curves, &c. The first 170 pages are occupied by the tables for the cubic contents of cuttings and embankments. Next follows a demonstration of the prismoidal formula and illustrations of the accuracy of the calculation by this method compared with that generally used by contractors. After explaining the method of using the foregoing tables, the author gives a description of a *graduated scale* for measuring earthworks, without the necessity of referring to tables. A woodcut, representing one of these scales made by Elliot, accompanies the following description:—

"I now proceed to give an explanation of a scale for measuring earthwork, which I have successfully used on the Eastern Counties Railway. The vertical and horizontal scales, and also the base and slope, must be previously determined for each scale, and then a set can be formed embracing the required slopes of the railway. My scales were made four in number, for base 34; slopes 1, 1¼, 1½, and 2 to 1; and on the back of each was properly described the slope, base, and vertical and horizontal scales to which they were applicable. All the dimensions were taken in yards lineal, superficial, or cubical, as required; the application being precisely the same as the use of the tables, and the rules being the same to find the *area*, using 2 as a co-efficient instead of 6. Owing to the fineness of the graduations, I would not advise, to insure accuracy, that the vertical scale be made less than 40 feet to 1 inch, and, generally, the larger the better. 20 feet to 1 inch vertical is a good working scale. The lengths can be made to suit convenience. There is no necessity to measure the heights or lengths previously, and the same form must be used as before described.

To Measure a Cutting by the Scale.—Apply the zero of the scale of sectional areas vertically to the gradient or formation line, and read off where the surface line intersects; put this in column 1 or 2, as the case requires: then, at the smaller end of the prismoid, upon the scale of vertical yards, with zero on the surface line, observe where the gradient intersects, then place the same point of intersection on the gradient at the other end, and read off above the zero on the scale of differential areas, where the surface line intersects; put this in column 4, and then, having measured all the lengths by the scale of horizontal yards, proceed as in the use of the tables. To save time, it is desirable to take a pair of dividers, and mark off at each division the difference of the heights in succession, and then the differential scale above zero need only be applied.

This method of computing cubic contents of cuttings and embankments is very expeditious with a little practice, and is quite as accurate, and generally more so, than the calculating by feet and the tables; because, in a working section, the points of intersection of the scale and surface line can be estimated readily by the eye; but, in using an ordinary scale of equal parts, we are compelled to neglect the fractional parts of a foot."

The above extract is followed by tables of areas required on a railway for cuttings and embankments of various heights and slopes; tables for estimating the superficies of slopes; for finding the radius of a curve of which the chord and the angle contained between the tangents to the two extreme points of the arc are known, &c.

The part of the work which refers to mensuration is followed by essays on the resistances to locomotives, and the relation of the power of the engines to those resistances. These essays, however, are not altogether satisfactory; for instance, the resistances in question are stated to be these three,—the friction of the carriages, &c., the resistance of air, and the resolved part of the weight on an incline; the author has, however, neglected the resistance due to the blast-pipe, which frequently at high velocities causes a pressure of 8 or 9 lb. per square inch on the piston. The following passage is altogether erroneous—the author is calculating "power" necessary for drawing a given load; D is the diameter of the driving wheel, *a* the area of the piston, *l* the length of the stroke:—

"Let *p* represent the pressure (60 lb. on the inch), and let the previous notation be used, then the general expression of the power is $pal \div D$ for one cylinder only. The ratio between the greatest effect of one crank, and the mean effect of two acting simultaneously at right angles to each other, is nearly as 10 to 16; and adopting this proportion, we have $1{\cdot}6 \times pal \div D =$ power of two cylinders."

This short extract contains three errors, either of which would be fatal to the conclusion arrived at. First, the pressure in the cylinder is supposed to be the same as that in the boiler, whereas the relation of these two pressures to each other depends on the velocity or number of strokes per minute; for the more frequently the cylinders have to be filled in a minute, the more will the steam be dilated in passing from the boiler. Next, the "general expression of the power" $pal + D$ is erroneous, for the relation of the pressure on the piston to that exerted by the driving wheel depends on the proportion of the distance traversed by the piston, to that traversed by a point in the circumference of the driving wheel; consequently, supposing the above formula correct in all other respects, we must substitute the length of the *circumference* for that of D the *diameter*. Lastly, the ratio 10 : 16 could not have been arrived at except by a statical process, that is, by supposing the engine not in motion; for when it is moving, the ratio will depend on excessively complicated relations between the velocity, the load, &c.; moreover, the application of this relation here is hopelessly erroneous, for (*inter alia*) it is in direct opposition to the law that in machines force is neither gained nor lost by transmission, excepting so much of it as is absorbed by friction of the mechanical organs.

It is due, however, to the author to state, that the theoretical essays are not considered as integral portions of the work, and that in the part which refers to mensuration everything has been done to facilitate calculation and to render the tables convenient for reference.

Ancient and Modern Architecture; consisting of views, plans, &c. Edited by M. Gailhabaud. Parts 43, 44, and 45; quarto. Didot. 1846.

The concluding parts of the second volume of this series, which has been before favourably noticed in this Journal, are now before us. They contain views, sections, and details of the Treasury of Atreus, at Mycenæ, a monument of Pelasgian architecture, and five plates, illustrating the Church of St. Francis, at Assisi, in Italy, built in the Pointed style of the thirteenth century. We have little to add to our former notices, except the necessity of making the plates architectural instead of pictorial seems to have been more carefully regarded in the latter parts of the work than in the commencement of it. The following extract from the description of the church at Assisi may suggest some reflections to those who advocate the universal adoption of high roofs in Pointed architecture:—

"The lofty gable which surmounts the front does not attain the object aimed at by the architects of the North in the pointed forms of their Gothic fronts. The climate of northern countries required the roof to have a very high pitch; the architectural decorations were conceived so as to harmonise with this necessity. In Italy it had always been usual to cover buildings with low roofs; and architects even in the Middle Ages should have conformed to this long establised practice. This high and useless gable, forming an isolated wall of a very unpleasing effect, and exposed to all the winds of heaven, is an anomaly that would seem to indicate the northern origin of the architect of the church of Assisi. . . . . In the upper nave, the trefoil arches, the tall openwork gables, the capitals with vegetable ornaments, all so common then in the North, are too boldly employed to be attributed to Italians, who were then novices in this Northern style. Let us add, that the mullions of the windows have the shape and outline of those executed at the same date in France and Germany; and that this edifice is the only one beyond the Alps that contains a series of painted windows so complete and so strictly in keeping with the general character of the building. The Pointed style was still a novelty in Italy at the beginning of the thirteenth century, when the church of Assisi was built; it was called *tedesco*, or German, and only a few essays had been made. At this epoch, what Italian artist could have conceived so perfect, so well-proportioned a whole, in a style then quite new to him? The isolated gable, which serves no useful purpose in the climate of Italy, though so appropriate in the North, seems to prove the northern origin of the architect, who could not allow himself to disfigure the pointed forms to which he was accustomed, by reducing them to the low pitch of Italian roofs—a modification which Niccola Pisano introduced in Gothic architecture, when he built the church of Saint Antony, at Padua; as Simon Andreozzi did in the side elevations of the Ara-Cœli, at Rome; and as many other Italian artists contemporary with the Pointed-arch period have done, but in general very imperfectly, in numerous edifices scattered about Italy, from Venice to the kingdom of Naples."

The last number contains the title-page and index of the volume. The third volume will be published in December.

NEW LAW OF COMPOUND MOTION.

At the last *soirée* of the Marquis of Northampton there was exhibited an instrument by Mr. Perigal for developing a peculiar law of compound circular motion; the following description we extract from the *Literary Gazette*. It is an instrument for "generating *retrogressive* or *recurrent* curves, by which the moving body, when it has reached the extreme points of the curve, retrogrades or returns back in exactly the same line along which it advanced; constantly moving forward and backward from one extremity to the other; and always tracing and retracing the same line as it alternately advances and recedes."

These curves were produced by a complicated system of wheel-work, which Mr. Perigal stated to be capable of generating numberless varieties of curves dependent upon the ratio of the velocities of the movements; but the instrument was, on this occasion, adjusted for the production of parabolas or hyperbolas, and a sort of figure of 8 curve, resembling a lemniscate, which he showed to be different forms of one and the same curve, just as circles and right lines are (limits or) varieties of ellipses. When the tracing-point passed through the centre, the curve was at one of its extremes or limits; and the two ovals of the figure of 8 were opened to their fullest extent of roundness; but alterations in the angular adjustment of the movements caused these ovals to become more and more flattened, till they ultimately converged or collapsed, and became in appearance a single line, terminating in points, with the form of a parabola or hyperbola; and the tracing-point travelled forward and backward from one extremity of the curve to the other repeatedly, without in the least degree thickening the line in one part more than in another; evidencing that it advanced and receded in exactly the very same path! In fact, the line of return might be considered as superposed upon the line of advance; as Mr. Perigal remarked, in reply to a very eminent mathematician, who objected that the figure of 8 curve was a line of the fourth order, inasmuch as it could be cut by a straight line in four places, while the parabola was a line of the second order, because it could be so cut only in two places; but the suggestion of its being a double line superposed seems to remove the difficulty.

Mr. Perigal informed us that one of his objects was to exhibit the parabola in the novel character of a *retrogressive* or recurrent curve of definite range; whence he inferred, that *if a comet moved in that curve* (as most of them are said to do) it *might return* after it had performed its allotted journey, *and continue to visit us periodically*, as several do, which are therefore supposed to travel in very elongated ellipses, although their apparent path more resembles a parabola.

We do not take upon ourselves to decide that this "*retrogressive*" curve of Mr. Perigal is or is not identical with the parabola of Apollonius; but we can bear testimony to its striking resemblance to the conic section; and affording at least *prima-facie* evidence of its relationship, however much its newly discovered property of "*periodicity*" may shock the prejudices of those who have hitherto thought themselves learned in such matters. Besides, it is well known that reciprocating straight lines can be produced by combinations of circular motions; and, therefore, we cannot see why it should have been deemed impossible so to produce parabolas and hyperbolas, which, being curved lines, would even appear the less unlikely. Of the importance of the discovery in reference to the cometary theory, our scientific readers can judge for themselves; and such of them as are mathematicians can, for their own satisfaction, put the question to the proof by submitting the problem to analytical investigation.

POWER TO OVERCOME INERTIA OF RAILWAY TRAINS.

Paper read at the Royal Society, on the *Investigation of the Power consumed in Overcoming the Inertia of Railway Trains, and of the Resistance of the Air to the Motion of Railway Trains at high velocities*, by P. W. Barlow, Esq.—The object of the author in this enquiry is to obtain a more correct knowledge than has hitherto been possessed of the resistance which the air opposes to the motion of locomotive engines at high velocities, and of the loss of force arising from increased back pressure, and the imperfect action of steam. For this purpose he institutes a comparison between the velocities actually acquired by railway trains with those which the theory of accelerated motion would have assigned; and his experiments are made not only on trains propelled by a locomotive engine, but also on those moving on the atmospheric railway, which latter afford valuable results, inasmuch as the tractive force is not subject to the losses at high velocities necessarily incident to locomotive engines. A table is given of the theoretical velocities resulting from calculations founded on the dynamical law of constant accelerating forces, in the case of trains of various weights, impelled by different tractive forces, moving from a state of rest, and is followed by another table of the observed velocities in Mr. Stephenson's experiments on the Dalkey line; the result of the comparison being that, in a distance of a mile and a quarter, the loss of velocity is about one-half of the observed velocity. A series of experiments on locomotive lines is next related; but the comparison is less satisfactory than in the former case, because the tractive force cannot be so accurately estimated; it is, however, sufficiently so to establish the fact, that the power lost by the locomotive engine below the speed of thirty miles per hour, is so small as to be scarcely appreciable; and that the time and power which are absorbed in putting a railway train in motion are almost entirely required to overcome the inertia of the train, and do not arise from any loss or imperfection of the engine. It appears from these experiments that above one-fifth of the whole power exerted is consumed in putting the train in motion at the observed velocity. In the atmospheric railway the author finds that the tractive force of a fifteen-inch-pipe is so small (being less than half that of a locomotive engine) that the time of overcoming the inertia must limit the amount of traffic on a single line, especially with numerous stations. When a great velocity is obtained, the tractive force of the locomotive is much reduced, and, therefore, a much greater velocity can be attained on an atmospheric railway. The inquiries of the author into the amount of resistance exerted by the air on railway trains, lead him to the conclusion that on the atmospheric railway the loss of the tractive power of the piston from friction, &c., is very inconsiderable, and that the resistance of the air is less than had been hitherto estimated, not exceeding, on an average, ten pounds per ton on the average weight of trains. A tabular statement is then given of the results of the experiments made by the British Association for the purpose of comparison with those obtained by the author. The general conclusion which he arrives at is, that the resistance of the air in a quiescent state is less than had been previously estimated, and that the ordinary atmospheric resistance in railway progression arises from the air being generally itself in motion, and, as the direction of the current is not always oblique, from its producing increased friction in the carriages. This kind of resistance will not increase as the square of the velocity; and as it is the principal one, it follows that the resistance to railway trains increases in a ratio not much higher than the velocity, and that the practical limit to the speed of railway travelling is a question, not of force, but of safety.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL SCOTTISH SOCIETY OF ARTS.

March 23.—John Clerk Maxwell, Esq., F.R.S.E., in the Chair.

The following communications were made:—

1. *Description of a Water-wheel with Vertical Axle, on the plan of the Turbine of Fourneyron*, erected at Balgonie Mills, Fifeshire. By Joseph Gordon Stuart, Esq. The paper gave an interesting description of a Wheel on this principle recently erected by him at his flax-spinning works at Balgonie, in Fife, and a summary of its general advantages. The Turbine is, in general appearance, like an overshot wheel, laid on its side, and wrought at the bottom of the fall. The water enters it from the inner circumference of the crown, and quits it at the outer circumference, impinging on every bucket of the one, and flowing from every part of the other, at the same instant of time. The water is supplied from a reservoir rising above the wheel, in which it stands to the full height of the fall, and is discharged from the bottom of this reservoir through a cylindrical sluice, so as to be delivered not only on every bucket or curve of the wheel at the same time, but also with the full velocity due to its head. The problem sought to be solved in the construction of the curves is, that the water, which has entered without shock, should quit without velocity. On the nicety of this construction will depend the economy of power, but in general the useful effect obtained will be equal to that of the best constructed overshot wheel. The turbine has the advantage of the overshot wheel in being adaptable to any height of fall (such wheels are working on the continent on falls from 332 feet to 13 inches), in being generally cheaper in construction, and always much cheaper in maintenance,—in being little disturbed in its economical arrangement either by changes in the quantity of water supplied, or by being thrown in back water—and in going at such speed as greatly to economise the necessary connecting gearing for factory work. Mr. Stuart's paper, with the illustrative drawings and model, was remitted to a committee of the Society that they may report fully on the merits of that (in this country) novel mode of economising water power. When that committee have made their report it may be expected that the result will be laid more fully before the public, especially if it be such as to justify the expectations entertained by Mr. Stuart, of this being a most valuable improvement upon any water wheel hitherto in use.

2. *Notice of a Double Bell-Jar,—or Receiver,—for the Air Pump.* By James Tod, Esq., W.S., Sec. On a late occasion, in treating of his experiments on the relative capabilities of different gases to convey sounds, Dr. Wilson having stated that he had constructed the plate on which the bell-jar

of the air pump rests of thick plate glass, but that on exhausting the bell-jar, the pressure of the atmosphere had shivered the plate glass into pieces, Mr. Tod, in this paper, suggested a plan by which the necessary strength might be obtained, while, at the same time, all parts of the interior would be as visible as when the plate glass disc was used. Mr. Tod suggested that, by taking two semi-elliptical bell-jars, the one of which should be perforated at the bottom, and fixed in a brass or other collar attached to the pump, and the other made to fit upon its ground lip, there would then be a double bell-jar formed of great strength, able to resist the atmospheric pressure equally from above and from below; and that the galvanic wires could be introduced into the interior of the jar through perforations in the collar at the bottom and properly insulated.

3. *A Communication from Australia on a new arrangement of the Screw-Propeller.* By Mr. James Paterson, engineer. Melbourne, Port-Philip, Australia. In this new arrangement of the screw propeller, the screw is made to traverse in an angle of 30 deg., by means of a Hook's joint, and is thus intended to serve the purpose not only of a propeller but of the rudder. It is not fixed, as usual, in the dead wood, but at the outside of the stern post, just where the ordinary rudder is placed.

April 13.—Sir G. S. Mackenzie, Bart., F.R.S.E., President, in the Chair.

The following communications were made:

1. *Verbal observations on the use of the Fibres of Plants, and particularly on the use of the Plantain Fibre:* illustrated by Drawings and Specimens. By Professor Balfour, F.R.S.E.—Dr. Balfour made some general observations on the plants which furnish fibre for the purposes of manufacture. He noticed the difference in the tenacity of the woody fibre of various species of plants, such as flax and hemp, and illustrated by drawings of the form and nature of the fibre, as contrasted with the other tissues, and its distribution in the stems of herbaceous plants. Fibres, from various plants belonging to the nettle and mallow tribe, from screw pines, pine apple leaves, and palms; also New Zealand flax, Pita flax, African or Bowstring hemp, Bengal hemp, Coir, &c., were brought under consideration. Dr. Balfour then alluded to various trees, the bark of which furnished cordage, and such as the lime or linden tree, the lace-bark tree, and the East Indian sack tree or chandul (a species of Antiaris), which grows in the deep ravines of Kandalla, and in the jungle near Coorg. He then proceeded to notice various species of plants belonging to the banana and plantain tribe, as *Musa textilis, paradisaica, sapientum,* and *rosacea*, from which fibres have been prepared, the mode of preparation, the quantity yielded, and the nature of the fibre. Specimens of plantain fibres, in various states, were exhibited. In some of the specimens not fully prepared, the microscope showed, in addition to woody fibres, spiral and dotted vessels, which are by no means so tenacious as ligneous tissue. The fibres, although they bear a considerable weight, are not well fitted for the ordinary purposes of manufacture: they break easily when a knot is made on them. The communication was illustrated by fresh specimens of the leaves of many of the plants, from the Botanic Garden, and by a large drawing of the plantain.

2. *Description and Drawing of a Cabinet Lock and Key of a new construction.* By Paul S. Samuells, M.D. There are three plates in this lock, a back, a front, and a centre plate. A square hole is formed in each, but it is only the middle one which can be moved by the key; so that unless the key go down to the proper depth and no farther, the bolt cannot be shifted. There is also a back spring behind the bolt, on which two pins or studs are fixed, the one of which enters a hole in the bolt, which prevents it shifting until the spring be depressed by the key. The other pin or stud enters the pipe of the key; so that unless it exactly fits the length of that pipe, the key will not depress it far enough to relieve the bolt, or if too long, the key will not get into its place, but be caught by the outer square. Another advantage of this lock is, that on withdrawing the key, the bolt is necessarily locked.

3. *Description, with Diagrams, of a Hydro-Pneumatic Railway.* By Mr. George Clark, Edinburgh. The weight of water is made use of to compress the air, which is forced into the tube laid betwixt the two sets of rails. He then contrives an apparatus for opening the continuous valves of the tube, and for conveying the compressed air from it to the boiler of the locomotive, from which it is admitted to the pistons of the cylinders, as the steam is used, in the common method.

4. *Description of a Model of an improved method of Hanging Windows, whereby, at small expense, windows in common use can be so altered, that the Sashes can be taken out and cleaned, painted, or glazed, from the interior of the room.* By Mr. John Steven, Edinburgh. This simple method can be applied to all windows as now constructed at a very trifling expense, probably under five shillings for each window. The sashes can be taken out with ease and in about two minutes. There is nothing liable to get out of repair; and it possesses other advantages, such as allowing the upper sash to come down to the very bottom, the steps covering the pocket holes being removed to the inside frame. As a separate improvement, Mr. Steven recommends that in *new* windows the sashes should be made with a slight taper, so as to fit closely when shut, but to move freely when pulled up or down.

5. *On a Machine for Beating Carpets, Wringing and Drying Clothes, &c.* By Mr. John Baillie, Edinburgh. This consists of a broad wheel with four arms, on each of which leather is stretched—and on being turned round by a handle, these leaves strike on the carpet, while the broad leather fan drives away the dust. The wheel is then reversed, which beats the under side of the carpet, which is brought in successive parts under the beaters. By having a hook attached to the axle of the wheel, heavy clothes, such as blankets, may be easily wrung; and the wind of the fans speedily dries them when suspended within its influence.

SOCIETY OF ARTS, LONDON.

March 25.—G. Moore, Esq., V.P., in the Chair.

The first paper read was, by the Rev. Dr. Thompson, "*On the Earthquakes of Peru and Chili.*" The paper also described the peculiarities of the mountains of North and South America, and concluded with an account of the most celebrated earthquakes that have occurred in America.

The second communication was, "*On an Improved Safety Lamp for Miners.*" By Dr. Clanny. The improvement consists in preventing currents of air coming in contact with the flame; a glass, or other transparent substance, being substituted for the wire gauze at the lower part of the lamp. It is also less liable to be blown out than the Davy lamp.

April 8.—W. F. Cooke, Esq., V.P., in the Chair.

The following communications were made by Dr. Green, "*On a New Portable Stand for Telescopes with an Equatorial Movement, but without a Polar Axis.*" The subject of the improvement was introduced with an account of the telescope from the time of its discovery, and the improvements which have been made upon it up to the present time. He next alluded to the stand ordinarily used, and pointed out the peculiarities of the Herschelian, achromatic, and other stands, and the objections to them, arising either from their unsteadiness, unportability, or other causes; he then proceeded to point out the improvements which he had effected, by describing his own stand. The true principle upon which every stand ought to be constructed (observed Dr. Green) is to have the heaviest end of the telescope supported on a solid foundation, and the moving power should be placed as far as possible from the centre of motion. To effect both these conversions has been my aim in the stand which I now submit. As a triangular support is found to be the most steady, it has been adopted in this case, and pervades almost every part of the stand. The object-end of the tube containing the great mirror rests upon a circular disc, having a diameter about one-half larger than that of the tube. It is supported by three feet, which are not more than three-quarters of an inch high, so that it may be said to rest solidly on the earth. To admit of easy rotation, a second disc of the same diameter rests on the surface of the one described, and moves on three friction wheels round a pivot passed through the centre of each. Near the periphery of this upper circular disc, upon the opposite sides of it, are fixed, vertically, two flat pieces of brass, about half the diameter of the tube in height; upon these the telescope rests by means of two horizontal arms projecting from the sides. The object is to form a universal joint, and prevent the telescope rotating on its own axis. The upper end of the tube rests upon a pair of shears a little inclined towards the tube, thus the entire fabric is one large triangle, possessing the greatest steadiness. The shears are attached at their lower end to a horizontal bar, which slides in a groove. The bar is worked by means of a universal joint and rack and pinion, and by which the slow motion in azimuth is given. The shears are so constructed as to admit of being lengthened or shortened. The fine movement in altitude for finding a star is provided by a slide on the outside of the under part of the tube, to which slide the shears are attached. The slide is moved by a rack and pinion. The equatorial movement is the link of connexion between the head of the shears and the slide for the fine altitude movement, and is thus effected:—the two legs forming the shears are hinged together at the top by a circular joint, in the centre of which is inserted a piece of brass, which carries the equatorial movement slide, and is worked by a toothed-wheel and pinion. The equatorial slides are attached to the altitude slide by a universal joint. By placing the lower end with the discs it rests upon, on a tripod, this frame may be made to suit the Newtonian telescope for viewing terrestrial objects.

2. "*On a Process for the Preservation of Animal and Vegetable Substances with their forms and colours unimpaired.*" By Dr. J. Silvestri.—A number of specimens of preserved animal and other substances were exhibited.

3. "*Specimens of a new process of dulling the surface of electrotypes.*" By Mr. Colchester, and also *specimens of a new method of bronzing*, by Mr. Loope, were also exhibited.

April 15.—T. Webster, Esq., V.P., in the Chair.

The first communication was on "*Mr. Rand's inventions for the Manufacture of Flexible Metal Vessels for preserving paint and other matters.*" By W. Carpmael. Mr. Carpmael stated that Mr. Rand, who is an artist, had, from the inconvenience and waste of colour which takes place when it is put up in the bladders ordinarily used, been led to endeavour to find a substitute, and the use of metallic vessels suggested itself. After experiments he succeeded in forming them of so thin a body of metal that they are capable of being collapsed so as to shut out all air. The tubes are made of block tin the 150th part of an inch in thickness, and have at their upper end a nozzle and screw cap, and are closed at the bottom by being folded over once or twice with a pair of pincers so as to exclude all air. As the colour or other matter which they contain is pressed out, the tubes are collapsed and thus the upper part of the tube always remains full. Each tube has to go through the following process of manufacture.

A small piece of block tin is put into a die upon which a punch worked by a fly-press descends and forces the metal up, of the required thickness, between the surfaces of the die and the punch; thus by a single blow the body of the tube is formed. It is then removed to a second press, by which the screw on the neck of the tube is formed, and by a second blow, in the same press, the maker's name is stamped upon it. The cap is formed in a similar manner by a third machine. The tube when struck is placed on a lathe and cut the required length. Thus an air-tight bottle is formed without seam in a few seconds.

The second communication was by Mr. Banks, on the Cotton produced in Honduras and Yucatan, and the practicability of introducing free-labour cotton from Africa and other countries into the British market. The object of the communication was to point out the importance of our cotton manufactures—the successful competition of white and grey fabrics with those of Britain in foreign markets—the great production of raw materials by slave labour in the States—the general inferiority of the cotton imported from India—the practicability of obtaining larger supplies by free labour, from other quarters within our reach—the improvement of the staple, and consequently of the fabric, and the opening of a new market with Africa and elsewhere.

April 22.—R. TWINING, Esq., V.P., in the Chair.

The first communication was by Mr. Banks, who resumed his paper on cotton produced in Honduras and Yucatan, &c. He proceeded to show why the American white and grey fabrics maintained a higher price and so successfully competed with the British manufactures in foreign markets. He next described the peculiarities of the kinds of cotton; and means resorted to by the Americans for cleaning or freeing the cotton from the seed,—namely, the Saw Gin. The amount of cotton exported to England from America he stated to be 1,600,000 bales per annum; while that from India and other countries amounted to only 500,000 bales. He next proceeded to show that the sea-coast of Africa presents a large territory which is capable of being made to produce cotton in larger quantities, and of a quality equal, if not superior, to the American. From inquiries which had been made at the Wesleyan and Baptist Missionary Societies, he had ascertained that the missionaries of both those Societies have instructions to promote such objects as the cultivation of cotton among the natives at their several stations, which extend all along the coast of Western Africa—and he strongly urged the necessity of their introducing the saw gin, in lieu of the roller gin and hand labour, to free the cotton from the seed, and the screw-press for packing it into bales.

The second communication was by Mr. Keyse, on *an apparatus for preserving life by supporting persons when in the water.* It consists of a covering for the arms, which are made of mackintosh cloth, and are capable of being inflated, of a pair of webbed gloves, and also a pair of cork clogs, with concave bottoms. The apparatus is stated to give an additional buoyancy of 35 pounds to the body.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

Extract from the Minutes of the Ordinary Meeting, held on Monday, March 23, 1846.

Resolved,—That the Medals of the Institute be awarded next year to the Authors of the best Essays on the following subjects:—

1. On the Adaptation and Modification of the Orders of the Greeks by the Romans and Moderns.

2. On the best system to be adopted with regard to the arrangements for the thorough Drainage of a Town House, and of a Nobleman's Mansion and Offices in the Country, respectively. Comprising the general arrangement for carrying off the Waters and Sewage, the sizes and most convenient forms for the Drains or Conduits, the requisite fall, the description of material to be employed, and the several precautions for the prevention of damp, smell, and passage of vermin;—to be accompanied by block Plans and Details.

N.B. Each Essay to be written in a clear and distinct hand, on alternate pages, and to be distinguished by a Mark, or Motto, without any name attached thereto.

Resolved,—That the Soane Medallion be awarded to the best design for an Edifice, suitable to the Congregational Worship of the Church of England, and capable of accommodating One Thousand Persons, without Galleries.

The design to be Roman or Italian, expressive of its purpose both internally and externally, presenting as little obstruction to sight as possible. The Chancel to be properly marked in Plan and decoration, with reference to its Protestant uses. All the Windows to be charged with stained glass.

There must be a conspicuous Belfry, but the body of the Church is not to be surmounted by a Dome.

The Drawings of the Elevations and Two Sections, to be to a scale of one-quarter of an inch to a foot,—the Plans and Perspective View to one-eighth of an inch to a foot, and tinted with India ink or sepia only.

The competition is not confined to Members of the Institute.

DIRECTIONS FOR CANDIDATES.

Each Essay and set of Drawings is to be accompanied by a sealed letter, containing the name of the writer within, and on the outside the same motto as that attached to the Essay or Drawings; this is to be enclosed in a sealed envelope, containing an address to which a communication may be sent of the decision of the Institute, and directed—

To the Honorary Secretaries of the Royal Institute of British Architects.
Essay for Medal (or) *Drawings for Medal (Motto).*

The Packet, so prepared and directed, is to be delivered at the Rooms of the Institute, on or before the 31st of December, 1846, by Twelve o'clock at noon.

The Council will not consider themselves called upon to adjudge a Premium, unless the Essays or Drawings be of sufficient merit to deserve that distinction; and, if the best Drawings should be by a candidate who has been successful on a former occasion, the Institute reserve to themselves the power of adjudging such other adequate reward as they may think fit, and of awarding the medals offered to the second in merit. The Essays and Drawings, to which Premiums are awarded, become the property of the Institute, to be published by them if thought fit. In case of the papers not being published within eighteen months after receiving the Medals, the authors will be at liberty to publish them.

The object of the Institute is not merely to draw the attention of the Students, and younger members of the Profession, to the important theoretical and practical subjects which are annually brought forward as subject matter for the Prize Essays,—they have a still higher aim;—they would wish to enlist the experience, the judgment, and the taste of those profoundly acquainted with the several departments of the Art, whether Members of the Institute or not; in the hope of collecting a series of authoritative Essays upon every branch of Architecture, considered both as a Fine Art and a Science, so as ultimately to form an important body of information on Architecture, both decorative and constructive.

The Institute trust that this appeal to professional men will not be in vain, and when they consider the honoured names of Palladio, Chambers, Rondelet, Smeaton, Tredgold, Nicholson, Krafft, and others who have done so much, and deservedly gained so much honor in like investigations, they cannot but confidently hope that many other men of erudition, taste, and science, will be induced to add in like manner to the stores of Architectural knowledge.

April 20.—EARL DE GREY, President, in the Chair.

A paper was read by the Rev. RICHARD BURGESS, on "*The Ancient Triumphal Arches.*" The paper commenced by explaining the purposes for which those monuments were erected; that they were properly divided into two classes, arches of triumph and honorary arches. The former placed nowhere but across triumphal roads, like the Via Appia, Via Flaminia, and other great approaches: the Via Sacra, by which the procession moved to the Capitol, was distinguished by several. The honorary arches were placed where the acts they commemorated had taken place, as the Arch of Trajan at Ancona, where that Emperor had built a port, the Arch of Augustus at Susa, at the foot of Mount Cenis, where Augustus passed in journeying to or from the transalpine provinces. Mr. Burgess having established this distinction, then enumerated all the arches now existing or known to have existed in Rome or Italy, in chronological order. Before proceeding to the description of the principal existing arches, he described a triumphal procession, especially taking Vopiscus's account of Aurelian's triumph. After disposing of the provincial honorary arches, and some general remarks on such as might be termed mere gateways, the paper contained an historical account of the arches of Drusus, Titus, Septimius Severus, and Constantine in order, and to the historical account were added various architectonic observations, and illustrations of the ornaments which still exist upon those arches. Mr. Burgess pointed out the decline of Art in the arch of Septimius Severus, and the perfection of it in that of Constantine, which he showed to have been an arch belonging to the best age of sculpture, and was adopted but not erected by Constantine. In the course of the dissertation Mr. Burgess paid a tribute of respect to the memory of the late Mr. Basevi, and mentioned the Fitzwilliam Museum, at Cambridge, as a fine example of genius soaring above the little expedient of loading with ornament that which was deficient in architectural result. Mr. Burgess took occasion to compare the pageantry of the Roman triumphs with the modest deportment of our commanders, and drew some parallel between the Indian victories and those of the Romans in Asia, and the paper was concluded with a reference to the influence of Christianity in moderating the proceedings of modern warfare.

The President announced that the Académie Royale des Sciences, des Lettres et des Beaux Arts de Belgique had expressed a desire to place itself in communication with the Institute; and likewise that the Accademia Olimpica, of Vicenza, had acknowledged the receipt of the report of Messrs. Poyuter and Donaldson, the honorary secretaries, on the collection of drawings by Palladio, in the possession of the Duke of Devonshire, and as a mark of their sense of the courtesy of the Institute on the occasion, had elected Messrs. Poynter and Donaldson, Members of that Academy.

The Honorary Medal, voted on the 17th of November last, to the Chevalier Beuth, as a testimonial of the sense entertained by the members of the Institute of the benefit conferred by him on the art during the period he held the important office under the Prussian Government, from which he has retired, was presented, with an appropriate address, to the Chevalier Hebeler, who had been requested by the Chevalier Beuth to receive it on his behalf.

The Prize Medals awarded on the 23rd of February, were presented by

Earl de Grey:—to Mr. Worthington; to Mr. S. J. Nicholl; and to Mr. J. F. Wadmore.

The President announced that the Queen had been graciously pleased to bestow a further mark of favour upon the Institute, by giving annually a gold medal for the promotion of the useful purposes of the Society, and that the regulations connected with this gratifying instance of Her Majesty's continued favour, would be forthwith determined and communicated at the earliest opportunity.

DECORATIVE ART SOCIETY.

Mr. E. Cooper exhibited a process for producing a volute by means of a natural form. He had selected a shell, the *Buccinum spiratum*, or *Syracuse whelk*, and affixed it to a board; a string with crayons attached was then wound along the spiral hollow of the shell, and this, in the course of its convolutions, delineated what he assumed to be the Greek volute. He compared the result, satisfactorily, with engravings, by Nicholson, from the Ionic capitals to the Temple on the Illissus and the Temple of Bacchus at Teos, and he also had detected an exact correspondence in size in Inwood's Erechtheion, plate 21, from the Temple of Victory on the Acropolis. Mr. Cooper then explained that, in an examination of an Ionic capital in the British Museum, he observed that the eye had been fitted with a stone *similar* to the other parts; and, further, that in another instance the eye had been lost out. The orifice thus exposed, he conjectured, had been necessarily made to receive an instrument for guiding the tools used in working mouldings on the face of the volute. Its diameter agreed very nearly with that of the lower part of his shell, and he presumed that a modified cast in metal from the shell would supply an instrument suited to such a purpose, and which, at any rate, offered an inexpensive and ready mode of striking scrolls for hand-rails, &c. Mr. Tapling tested the volute described by Mr. Cooper by a notation of eight radial intersections, and he contended that the scale of expansion was different from that of the Greek volute. His remarks were afterwards sustained by a comparative experiment upon a mbbing which Mr. Cooper had in his possession. It was also said, that the engravings referred to by Mr. Cooper were incorrect.

NOTES OF THE MONTH.

One of the entire floors of the new Houses of Parliament of the building facing the river, is to be completed forthwith for the numerous committees that are likely to be called into action by railway proceedings in the Houses of Parliament.

Mr. Ambrose Poynter, the indefatigable Hon. Sec. of the Royal Institute of British Architects and the architect of numerous ecclesiastical buildings, and Mr. John Shaw, architect, of Christ's Hospital, have been appointed, under the new act, official referees in place of Mr. Higgins, who some time since resigned the appointment. We feel assured these appointments will give great satisfaction to the profession.

We regret to announce the demise of Mr. Le-keux, justly celebrated for the accuracy and neatness of his engravings connected with architecture.

Lord Mahon has been appointed President of the Society of Antiquaries. It is time that this Society commenced a revolution in its proceedings; it ought to embrace all the intentions of the two rival Societies—the Archæological Institute and Association.

The Royal Academy has announced for its architectural prize, to be awarded on the 10th December next, a silver medal for the most accurately finished drawings of St. Peter's, Cornhill; the plan, elevation, and section to be drawn from actual measurement.

The progress of the new Houses of Parliament have been greatly delayed on account of Dr. Reid's system of warming and ventilation; serious disputes have arisen with Mr. Barry, the architect, who was obliged to take his stand against the enormous inconvenience Dr. Reid's works occasioned to the progress of the building. At length Government has taken the dispute in hand; in the House of Lords, Viscount Canning announced that three gentleman had been selected to enquire into the whole subject connected with both the warming and ventilation, and to advise Government thereon. The gentlemen to whom instructions have been addressed are Mr. Hardwick, so well known as the architect of the new dining hall and library at Lincoln's-inn; Professor Graham, the Professor of Chemistry at the University of London; and Mr. George Stephenson, the engineer, a gentleman who, apart from his general scientific reputation, has given much attention to the subject of ventilation.

The ancient temple of the Knights of Malta, at Laon, has been completely restored under the auspices of Government.

A statue of Sophocles is on its way from Athens to Paris, to be placed in the Louvre. It is said to be one of the most remarkable antique works of art.

At New York, the new Trinity Church, said to be one of the best examples of Gothic architecture in that city, is nearly finished. It has a tower and crocketed spire 300 feet high; and the windows are filled in with stained glass.

M. Blouet, architect to the Arc de l'Etoile (given in the Journal, vol. II., 1839), has been elected of succeed the Baltard professor at the School of Fine Arts, in Paris.

The restoration of the works at the Chateau of Blois, by M. Duban, is making great progress.

An electrophonic telegraph, the invention of Chevalier Laskott, has been presented by Professor Jacob to the Imperial Academy of Petersburgh. It is composed of a clavia of ten keys, ten bells of different sizes, and ten conducting wires, by which the letters of the alphabet, and words which they form, are expressed by sounds and harmonics.

On the Dublin and Kingstown Railway the consumption of coke per train per mile is 26¾lb., and the total cost of power and maintenance of way 10·7 pence.

Mr. Bidder, in his report on the recent gauge experiments (detailed in the Journal for February last, p. 49), gives the following results:—

	Narrow Gauge.			Broad Gauge.		
Date of experiment	Dec. 30.	Dec. 31.	Dec. 31.	Dec. 17.	Dec. 16.	Dec. 16.
Draft in tons	50	50	80	60	80	80
Distance travelled in miles	42	85	42	101½	100½	101½
Time in minutes and sec.	72 6	108 12	56 52	112 42	117 4	121 3
Water evaporated lb.	12215	19708	9900	22596	23489	24828
Ditto do. per mile lb.	291	232	235·7	282	233½	245
Ditto do. per hour lb.	10160	11150	10480	11696	12020	12309
Cubic feet per hour	162½	178	167	198	192½	196½
Coke consumed lb.	1381		1176			
Water evaporated per lb. of Coke lb.	9·8	9·6	8·8	7·8	7·19	7·12
Coke consumed per mile lb.	31·2	24	26·6	29·6	33·6	32·6
Pressure		71	60			
Engines		A		Ixion		
Surface of fire-box feet sq.		58		97		
Areas of blast pipes in circular inches		3364¼		372½		
Contents of cylinders do.		4725		4961		

The friction of air through tubes, Mr. Bidder observes, is tolerably well ascertained; it appears that, with a pressure of ·04 lb. per inch, the velocity of the air through the long tubes of the A engine used in the narrow gauge experiments was 16 miles per hour, and through the shorter tubes of the Ixion 18 miles per hour.

ARTESIAN WELLS IN CHINA.

It is about twenty years since the report of Artesian wells in that country has reached Europe, through the medium of the French missionaries. According to these statements, one single district of the Celestial Empire, equal in size to one of the provinces of France, contains more than 10,000 (?) Artesian wells, some of which attain the astonishing depth of 8 to 900 metres. These extraordinary soundings of the earth's surface are, it is said, made by very simple means, and for various purposes, of which one, certainly, is most extraordinary, and altogether peculiar to the Chinese. Some of them discharge a water greatly impregnated with common salt, others bring to the surface a bituminous oil, others in fine, seemingly by passing through coal measures in the state of ignition, exhale constantly combustible (hydrogen) gas. These are the so-called fire-wells of the missionaries, with which the Chinese procure the gas which they use for the evaporation of the salt brine of the adjacent wells.

The importance of these statements is easily conceived, not only in a *scientific* but also a *practical* point of view, as we might be able thereby to furnish our cities, at a nominal rate, with that vast quantity of gas we now consume, but the jealousy hitherto of the Chinese authorities prevents travellers pushing to that quarter. The French Academy of Sciences has, therefore, of late inspected with great interest the specimens of bitumen and brine which the director of the French missions in China has addressed to them. The only fact of importance elicited by the chemical analysis which these substances have been submitted to is the complete absence of iodine in the brine. M. Boussingault acted as reporter in this important transaction.

J. L——Y.

THE AURIFEROUS SAND OF THE RHINE.

Some observations on the utilising the hitherto hidden riches of this river have been laid before the French Institute, by M. Daubrée, Engineer of Mines at Strasburg. It has been calculated that the amount of gold contained in the sand of the above river amounts to 25,916 kilogrammes, of the value of 114 millions of francs. M. D. has made many experiments to determine how the particles of gold detached from the Alpine rocks are distributed in the alluvion (*atterissements*) of the banks of the Rhine.

The pebbles most usually searched after for gold are those which the river deposits at a short distance from the stratum, subjected to the abrasion of the waters. It is on the upper part of banks thus formed, in the midst of large pebbles, to a depth of not more than 15 centimetres, that gold is to be met with. Out of the *actual* bed of the river, gold is also to be met with in the ancient deposits of the river, which form a band of 4 to 6 kilometres broad. In the fine sand without pebbles, such as is deposited in the hollows of the bed, no gold is to be found, any more than in the alluvial soil (slime), which, nevertheless, is of Alpine origin. The sand which is usually searched after for gold contains generally from 13 to 16 hundred millionth parts; it is rare that this richness passes 7 ten millionths. The revolutions, therefore, which the Rhine occasions, at times, in the contents of its bed changes the amount of gold from 1 to 70. The particles of gold are always very small, 17 to 22 making only a kilogramme. Compared with the sand of rivers worked in Siberia and Chili for gold, the former are 5 times, the latter 10 times richer than those of the Rhine. The gold of the Rhine sand seems to be derived from the tertiary formation, and, in the first instance, from the schistous crystalline rocks of the Alps, as is the case with most other rivers which descend from these mountains.

J. L——Y.

STEAM NAVIGATION.

Three steam vessels of war, the *Sidon*, the *Odin*, and the *Termagant*, in course of construction at Deptford Dockyard, are on the eve of being launched. The Sidon steam frigate is constructed on a plan of Sir Charles Napier's, and appears a very fine looking vessel, very strongly put together. Although only two feet longer, and two feet broader than the Odin steam vessel building in the same yard, the Sidon is intended to carry 400 tons more coals than that vessel. She was placed on blocks on the 24th of June, 1845, and in exactly 10 months will be ready to enter her future element. All the parts of her machinery above water mark are to be constructed of malleable iron, and of great power to resist injury during actual warfare; and every beam across her decks has been secured with strong iron kneedbolts to the powerful timbers of her sides.—The Odin steam frigate was designed by Mr. Fincham, master-shipwright at Portsmouth Dockyard, and the whole of her frame is put together, and she will soon be ready for launching. She was placed on the blocks on the 19th of February, 1845.—The Termagant steam-frigate, constructing from a design by Mr. White, builder at Cowes, is a vessel of the same length as the Odin, designed by Mr. Fincham; but 3 feet 6 inches greater dimensions in her extreme breadth, and will have engines of 600 horse power.—The following are the dimensions of the three vessels:—

	The Sidon.		The Odin.		The Termagant.	
Length between perpendiculars	210 ft.	9 in.	208 ft.	0 in.	208 ft.	3 in.
Ditto of keel for tonnage ..	185	9¾	183	8¼	181	0
Breadth extreme	37	0	37	0	40	6
Ditto for tonnage	36	6	36	6	40	0
Ditto moulded	35	10	35	10	39	4
Depth in hold	27	0	24	2	25	9
Burden in tons	1,328		1,326		1,540	
Horse power	560		500		600	

Launch of Two Iron Steam Ships, at Liverpool.—The Diamond—This vessel was launched from the yard of Messrs. P. Cato and Co., south end of the Brunswick Dock, and the second of two fine iron steamers built by them for the City of Dublin Company, to run between Dublin and London. She is the sister-ship of "The Emerald," (and from the same moulds). She is to be propelled (in addition to sails) by the screw, with engines on the direct action principle. The model (as of the Emerald) was furnished by Mr. John Grantham, C.E., and is well adapted for the double object of considerable stowage and rapidity of propulsion. The vessel is lap jointed, or "clincher-built," in her upper-works, as well as below the water-line, a plan which, in vessels of her comparatively small burthen, is more expensive than the flush joint, but is not only stronger, but quite as pleasing to the eye, if the workmanship be equal to that in question. The Diamond is built in the most faithful manner in every point, and does equal credit to the spirited owners in the outlay, and to Mr. Cato and those under him.—The Antelope—her model, by Mr. Grantham, is fine, and, though sharp at the extremities, of such rotundity and swell in the body, without "a lump" in any part, that she promises to carry and to sail well. She is the property of Messrs. M'Tear and Co., who have spared no expense in her construction, and the builders, Messrs. Hodgson and Son, have done ample justice to her in every respect. This vessel will have, in addition to sails, auxiliary propelling steam-power by two engines of 50-horse each, turning a screw of 12 feet diameter, on the direct action principle, patented by Mr. Grantham. The engines are by Messrs. Fawcett, Preston, and Co. She is the first of an intended line of 8 vessels of the same class, to run between this port and Rio de Janeiro, and more intimately to connect this country and the Brazils in bonds of amity and commerce, the present passage, by sailing vessels alone, being generally long and tedious. The Antelope has a finely designed billet-head and appropriate decorations, executed by Mr. Robertson. The trail-boards, gilded on a white ground, represent, in relief, the antelope pursued by the tiger, and the foliated ornaments around are rich and chaste, giving the vessel a peculiarly light and "go-ahead" appearance. The quarter-galleries are of a corresponding design, and enriched with quivers, bows, and other emblems of the chase; and the stern carving also assimilates—the whole having a peculiarly new and elegant appearance. We learn that in place of drawing so much water as was expected, she drew two inches less than was calculated, thus showing a superior degree of buoyancy.—The following are the dimensions of the two vessels:—

	The Antelope.		The Diamond.	
Length over all	190 ft.	0 in.	.. 145 ft.	0 in.
„ of keel	168	0	.. ..	
„ between perpendiculars	175	0	.. ..	
Breadth of beam	26	4	.. 21	0
Depth of hold	17	0	.. 13	6
Burthen in tons ..	600		.. 300	
Diameter of screw	..	12	.. ..	
Horse power	100	..	.. 60	

Telegraphic Communication between France and England.—Amidst the many wonderful inventions of modern days, wherein the faculties of man have overcome difficulties apparently insurmountable, and made the very elements themselves subservient to his power and use, there are none more wonderful than that now about to be carried out by the establishment of sub-marine telegraphs, by which an instantaneous communication will be effected between the coasts of England and France. The British Government, by the Lords Commissioners of the Admiralty, and the French Government, by the Minister of the Interior, have granted permission to two gentlemen, the projectors of the sub-marine telegraph, to lay it down from coast to coast. The site selected is from Cape Grisnez, or from Cape Blancnez, on the French side, to the South Foreland, on the English coast. The soundings between these headlands are gradual, varying from seven fathoms near the shore on either side, to a maximum of 37 fathoms in mid-channel. The Lords of the Admiralty have also granted permission to the same gentlemen to lay down a sub-marine telegraph between Dublin and Holyhead, which is to be carried on from the latter place to Liverpool and London. The sub-marine telegraph across the English Channel will, however, be the one first laid down; the materials for this are already undergoing the process of insulation, and are in that state of forwardness which will enable the projectors to have them completed and placed in position, so that a telegraphic communication can be transmitted across the Channel about the first week in June. When this is completed, an electric telegraph will be established from the coast to Paris, and thence to Marseilles. This telegraph throughout France will be immediately under the direction of the French Government, as, according to the law of 1837, all telegraphic communications through that country are under the absolute control and superintendence of the Minister of the Interior. Upon the completion of the submarine telegraph across the English Channel, it is stated that a similar one, on a most gigantic scale, will be attempted to be formed, under the immediate sanction and patronage of the French Administration; this is no less than that of connecting the shores of Africa with those of Europe by the same instrumentality, thus opening a direct and lightning like communication between Marseilles and Algeria. It has been doubted by several scientific men whether this is practicable, and, indeed, whether even the project between the coasts of France and England can be accomplished; but it has been proved by experiments, the most satisfactory in their results, that not only can it be effected, but effected without any considerable difficulty.—'Globe.'

The "Lunar Corrector."—Invented by Captain Andrew Thompson, consists of an instrument, the principle of which depends upon the minute variation of small spherical triangles. It is formed by the third part of a circle of brass, having an index similar to a sextant, on which is set the apparent distance. The index bar and left limb are graduated, and furnished with moveable slides for performing what is termed "Laying off" the apparent altitudes; one of the slides being graduated also to a scale proportioned to the radius of the instrument, shows at the point of intersection, a number of minutes and seconds, which is the correction required; and then, by the help of a brief table, or by working a rule-of-three sum, the true distance is at once obtained. The great advantage of this instrument is its simplicity, and the little time—which, by the use of it, is required to work a lunar observation; in fact, the time required scarcely exceeds that required to find the latitude by a meridian altitude of the sun. At Messrs. Spencers, in the Minories, the invention may be seen.

Bricks.—Return of the duties paid upon bricks in the several excise collections in England from 1839 to 1845 inclusive. The total amount collected in 1839 was 459,664*l*.; and in 1845, 558,415*l*. The amount in 1839, in the London district, was 23,911*l*.; in the Manchester district, 34,793*l*.; and in the Rochester district, 24,173*l*. In 1845, in the London district, 31,267*l*.; the Manchester district, 44,290*l*.; and in the Rochester district, 44,644*l*. Including the metropolis there are 56 separate collections; in five of which, during the last year, the amount received was less than 500*l*.

LIST OF NEW PATENTS.

(From Messrs. Robertson's List.)

GRANTED IN ENGLAND FROM MARCH 31, 1846, TO APRIL 25, 1846.

Six Months allowed for Enrolment, unless otherwise expressed.

William Henry Moggridge, of 13, Old Burlington-street, Middlesex, dentist, for "certain improvements in the plates or pieces for the roofs and gums of the mouth, for attaching thereto artificial teeth."—Sealed March 31.

John Ainslie, of Alperton, Middlesex, brick and tile manufacturer, for "certain improvements in the arrangements for the manufacture of bricks, tiles, and other similar articles from clay and other plastic substances, and in the machinery or apparatus for the manufacture of bricks."—March 31.

William Spiby, of Carrington, Nottingham, engineer, for "improvements in the construction of furnaces used for heating water and other fluids."—April 1.

Harold Potter, of Darwen, Lancaster, paper manufacturer and stainer, for "improvements in printing or staining paper."—April 1.

Henry Crossley, of King William-street, London, engineer, for "certain improvements in the manufacture of sugar, and in the machinery and apparatus employed therein."—April 3.

Ferdinand Charles Warlick, of Deptford, Kent, gent., for "improvements in the manufacture of fuel."—April 7.

William Thomson, of Kilmarnock, North Britain, manufacturer and fur merchant, for "improvements in machinery for operating upon wool and other fibrous material, intended to be wrought into felted fabrics."—April 7.

George Lewis, of High Cross-street, Leicester, locksmith, for "improvements in the construction of shutters and blinds for windows and doors, and in the construction of doors."—April 7.

James Allingham, of Dublin, gent., and James William M'Ganley, clerk, of Dublin, aforesaid, for "certain improvements in steam engines."—April 7.

Joseph Hunt, of Brixton, Surrey, chemist, for "improvements in the manufacture of soda."—April 9.

Joseph Bunnett, of Deptford, engineer, for "certain improvements in water-closets, part of which improvements is applicable to other useful purposes."—April 15.

Peter Armand le Comte de Fontainemoreau, of New Broad-street, London, for "an improved mode of constructing certain parts of the harness of horses and other beasts of burden." A communication.—April 15.

Simeon Hyde, of the Strand, merchant, for "improvements in refrigirators."—April 15.

William Tutin Haycraft, of Greenwich, doctor of medicine, for "improvements in steam engines."—April 15.

Charles May, of Ipswich, Suffolk, civil engineer, for "improvements in machinery for punching, riveting, and shearing metal plates."—April 15.

Henry Mandeville Meade, of New York, America, gent., for "improvements in preparing food for animals when Indian corn is used." A communication.—April 15.

Elijah Galloway, of Buckingham-street, Strand, engineer, for "improvements in locomotive engines."—April 18.

Joseph Clinton Robertson, of Fleet-street, civil engineer, for "certain improvements in the manufacture of pins." A communication.—April 18.

John Gillett, of Brailes, of the firm of Ward, Colbourne, and Gillett, of Stratford on Avon, and Brailes, near Shipston on Stour, Warwick, agricultural implement makers, for "an improved machine or machines, for cutting, slicing, and otherwise dividing hay, straw, turnips, and other vegetable substances."—April 18.

Peter Bishop, of Birmingham, manufacturer, for "a certain improvement, or improvements, in the manufacture of bayonets."—April 21.

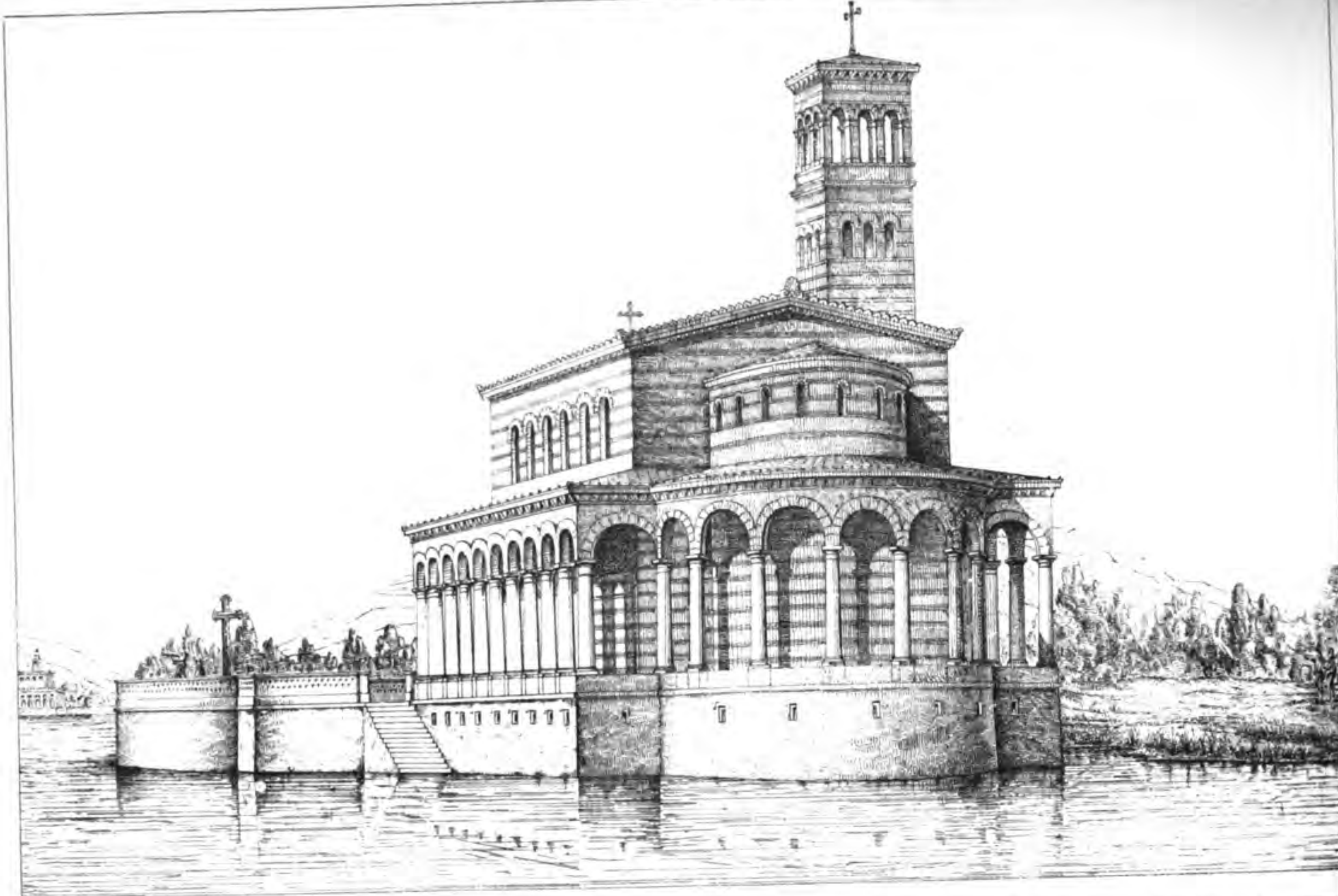
William Heward Bell, of Edmondsley, near Chester le Street, Durham, for "improvements in working coal in coal mines."—April 21.

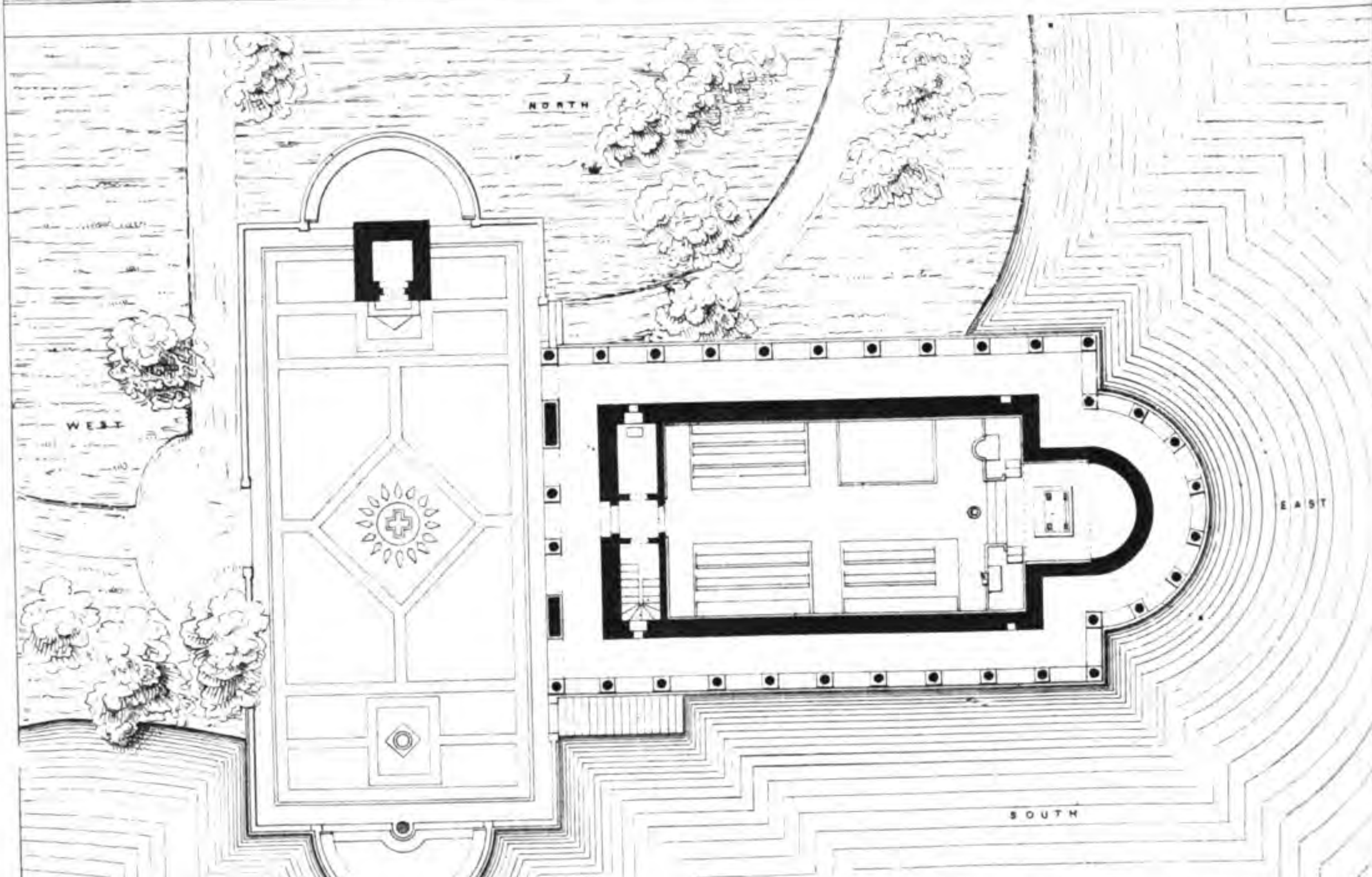
Arthur Philip Perceval, of East Horsley, Surrey, clerk, for "improvements in communicating between places separated by water."—April 23.

William Ashby, of Croydon, Surrey, millwright, for "certain improvements in the manufacture of flour."—April 25.

George Philcox, of High-street, Southwark, watch-maker, for "improvements in the construction of chronometers and other time-keepers."—April 25.

CHURCH OF SACROW · NEAR POTSDAM





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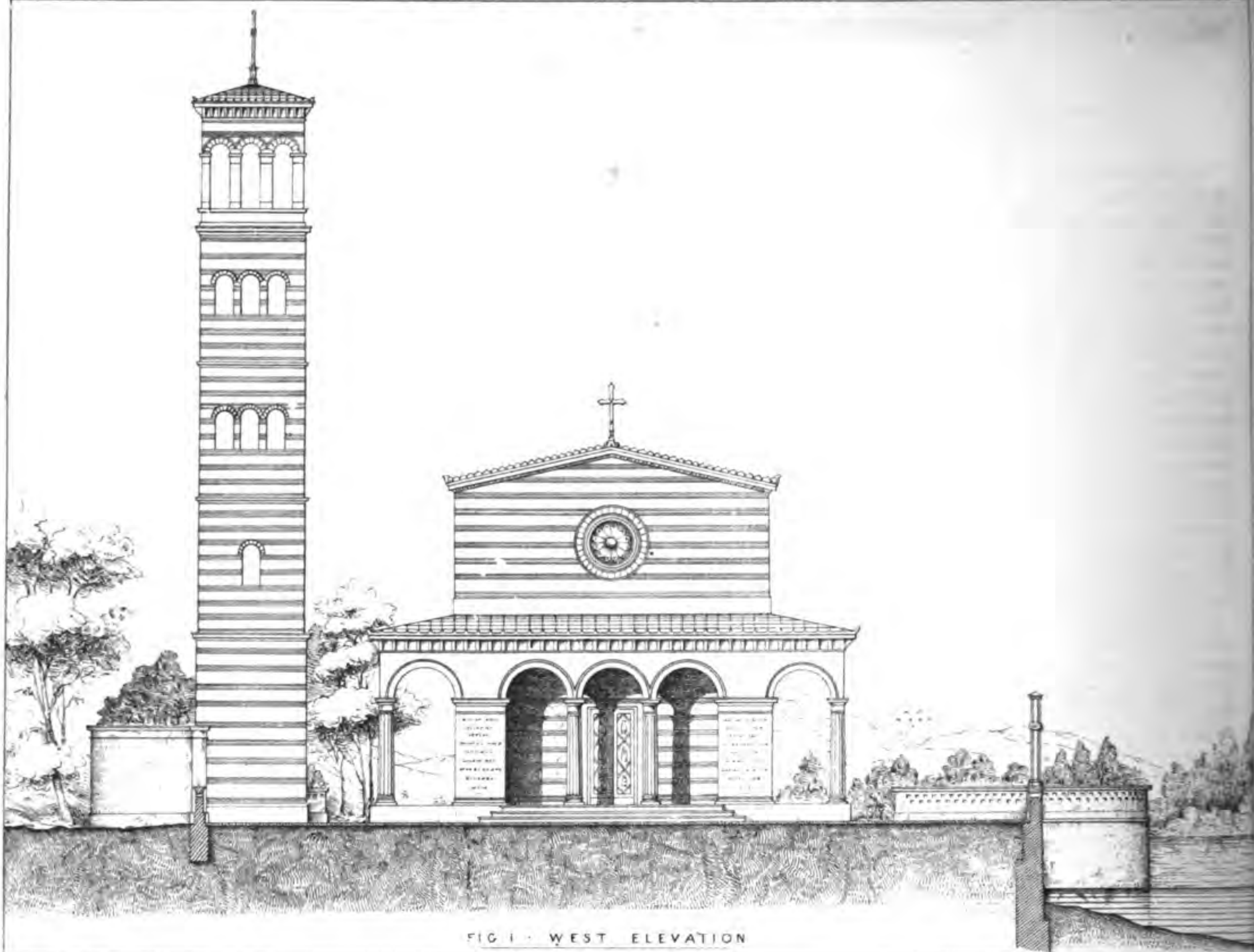
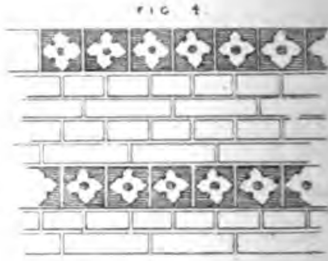


FIG I · WEST ELEVATION

FIG. 3

FIG. 4



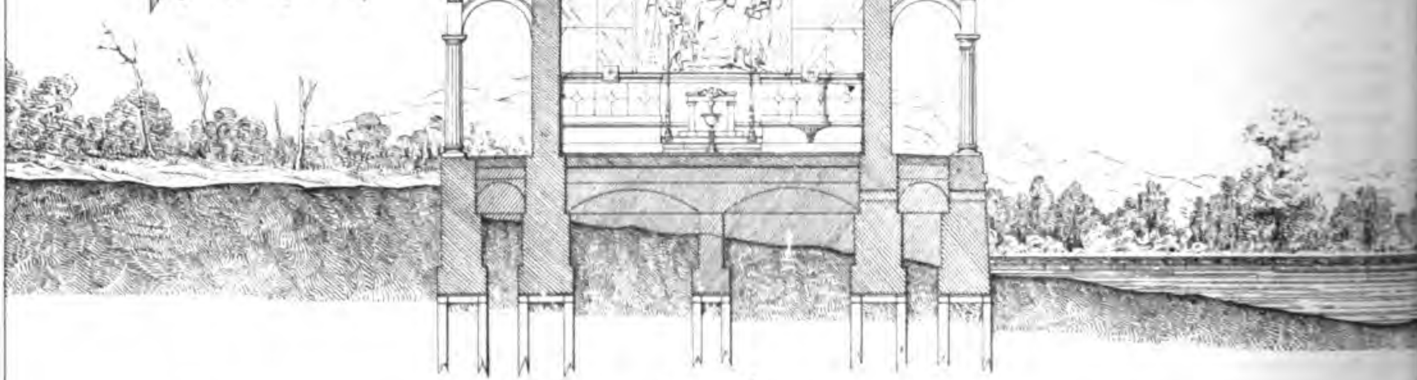


FIG 2. SECTION

SCALE · FIGS. 1 - 2 · 10 5 0 10 20 30 40 50 FEET

SCALE · FIGS. 3 - 4 · 12 9 6 3 0 1 2 3 4 5 FEET

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CHURCH AT SACROW NEAR POTSDAM.

(*With Two Engravings, Plates VII. and VIII.*)

Of considerable merit in itself, the subject of our engravings this month acquires additional interest from its being, besides the representation of an actual building—one moreover of very recent date—a work of Persius's, the present king of Prussia's architect, who died last summer. Relative to the individual himself we are unable to add any particulars to our notice of his death at page 348 of our last volume; for besides that he is *distinguished* by Nagler by being omitted in his tremendously comprehensive 'Kunster-Lexicon'—comprehending everybody who is of no note at all,—he is not given in the 'Conversations-Lexicon der Gegenwart,' notwithstanding that several German architects of the present day are there spoken of. Still we now know something positively both as to what he executed and what he merely designed; and sketches showing examples by him of both kinds have rather exceeded than fallen at all short of our expectations, for, to say the truth, some remarks which we had met with led us to apprehend that his works partook too much of flimsy showiness, of fantastic *spielerei*—as it was termed—and of hurried sketchiness, without due consideration as to detail and finish;—a not uncommon fault among those who study composition and general effects, while, on the other hand, those who are meritoriously attentive to beauties of detail and execution are apt to be either very indifferent to, or else negligent of, original composition and the character derived from it.

The Church at Sacrow,—one of the numerous structures with which Persius embellished the environs at Potsdam, is both picturesque in itself, and placed most picturesquely—even romantically, immediately on the Havel, where that river expands into a lake, and just over against Prince Carl's Park. We have before us a general "*situations-plan*," exhibiting the whole environs of Sacrow, as far as the Heiliger See, the Marble Palace, and Potsdam in one direction (West), and the Pfauen-insel, and Griebnitz See, in the other (East); which, map as it is, is also a picture, calling up images of landscape scenery interspersed with sinuous lakes, and enlivened by architecture—palatial residences, villas, casinos, bridges, belvederes, and what tantalizes us by its name of the Maurische Tempel. To confine ourselves to the Church of Sacrow itself,—it is charmingly placed—put just as a painter would have it, and perhaps just as a pedantic precedent-monger would not, for the latter prefers the prosaic in architecture, and leaves all touches of poetry in it to artist-architects. Taken merely by itself, the Church would be more than ordinarily striking, not on account of situation and *position*, alone, but for regularity and consistency of design, kept up throughout, since so far from consisting chiefly of a show front, or making most show just at that end, it captivates from every point of view, by its singular completeness, and also by its originality, the external arcade being a happy innovation upon the basilica character, from which class of ancient ecclesiastical buildings, the style has been borrowed,—but also freely treated, with artistlike feeling, and with many tasteful modifications—albeit the precedent gentry here may shake their heads at them. The Church, however, is only one feature in an architectural group, even the campanile only one of its accessaries; and that tower, a graceful object in itself, contributes to variety in a very unusual degree, inasmuch as by standing detached, it comes differently into combination with the main building, according to the direction in which they are viewed together. Architectural ensemble is greatly promoted by the enclosed area in front, a paved fore-court surrounded by a low parapet wall, partly forming a terrace, above river. Independently of its effect in other respects, this enclosure, simple as it is in character, is of great value, because it plainly connects the campanile and church together. In our opinion, too, such well expressed demarcation of site is a propriety which, notwithstanding our precise and affected scrupulousness in some matters of ecclesiastical architecture, is frequently most strangely overlooked by us, for we have churches in country as well as towns, that seem to have fallen down *from* heaven, alighting by road-side or street-side just as chance might direct, without any sort of interval or intermediate space between the secular and the ecclesiastical. Both this fore-court and the external ambulatory around the church may look to us like innovations; yet the one and the other hold out hints to us well worth adopting; and the one and the other afford excellent situations for monuments,—the walls of the church, for instance, within the arcade, might in time be quite incrusted with marble in monumental tablets,—but unless they were allowed only under proper restrictions—such as would ensure general symmetry as to arrangement and size, and further, preserve some keeping as to style, therefore nothing at all like the flagrant *post mortem* advertisements of quacks and charlatans which disgrace the Kensal Green Cemetry, and render it at once disgusting, and ridiculous,—embellishment of the kind would be only disfigurement.

The church at Sacrow, begun in 1842, and completed in all but its interior decorations the following year, is of very economic materials, nearly the whole of the exterior, excepting the columns of the arcade, which are of stone, being only of brick, nevertheless very ornamental, every four courses of the general brickwork being relieved by two others of coloured bricks (as shown in fig. 4), and similar ones, with a figured pattern upon them, form a sort of frieze or string-course just beneath the principal cornice. The pavement within the arcade is also of bricks of various sizes, so skilfully though simply disposed as to produce considerable richness of effect. All the other details, including those of the two cornices (that of the body of the church, and that over the arcade), are carefully studied, and manifest much clever invention as well as good taste. These minutiæ and peculiarities are, however, lost in drawings on the scale of those herewith given; wherefore it becomes necessary to observe that the capitals (fig. 3, plate VIII.) of the columns are also of novel design—partaking of Grecianism in taste, though quite dissimilar from Grecian examples,—without the name of a new order being therefore arrogated, even thought of, for them.

The interior of the church is sparingly, but tastefully, decorated: the walls are wainscoted for about the height of seven feet, and above that, are coated in imitation of pale green marble, whereby, at the same time, that offensive raw blankness of surface is avoided, the fresco-painting in the large altar or chancel tribune (designed by Professor Begas, and representing Christ and the four Evangelists,) is made to tell more effectively. The ceiling shows the timbers of the roof, which are partly relieved by colours, while the intermediate spaces are filled in with stars on a cobalt blue ground. The pavement forms a sort of mosaic work of three colours (dark green, dark red, and black) on a general ground of a pale reddish hue. The metal-work for the glazing of the windows is of ornamental pattern, the effect of which is heightened by some intermixture of coloured and ground glass; and it should be, remarked, that if they do not exactly constitute what we should call a clerestory, there is only one tier of windows in the upper part of the walls.

Taken altogether, the church at Sacrow will, we think, recommend Persius as one who thought for himself, and could seize upon and turn to account such points as opportunity and subject afforded him. For our own part, we like it very much better than some of Schinkel's designs for churches on about the same scale, which, to say the truth, are in a somewhat cramped and affected style, owing, perhaps, in great measure, to his deviating too far from, and yet keeping too close to, Greek orthodoxy. The sketch of another church by Persius, since erected at Sans Souci, shows a somewhat similar design, exclusive of the external arcade; yet, though the church itself is so far plainer than that at Sacrow, it forms only a portion of a widely-extended architectural assemblage of various buildings (some of them erected), all so happily brought together as to form quite a Poussin-like scene. His talent for combination, and his predilection for extending architectural accessories for some distance around the main building, so as to blend natural and artificial objects into one captivating *tableau*, are forcibly manifested in a design by him for altering a villa residence, which he has distributed in the most piquant masses, prominent among which is a noble belvedere tower (circular in plan), so placed as to form not only an adjunct to, but an object from, the mansion. This design, it appears, was intended for some place in the neighbourhood of San-Souci; whether it has been carried into execution we know not; but if the environs of San-Souci an Potsdam have been embellished in other instances by Persius, in a manner and taste at all similar, they must present some very charming architectural pictures, and we heartily wish that some such artist as Allom would visit—with *quantum sat* of drawing paper—Berlin and Potsdam—or, we might say, discover and explore them, for they seem to be utterly unknown to English artists.

We regret that we are unable to specify with tolerable certainty any other of the various buildings on which Persius was employed for some years previous to his death, and which, whatever their faults may be, no doubt display considerable power of fancy and warmth of imagination. It has, indeed, been said of him that he sacrificed too liberally to picturesque effect, yet, in an artistic point of view, that ought hardly to be made a reproach, provided the effect aimed at was really secured. Here, we frequently sacrifice a great deal in the shape of cost, without getting any return at all for it in the shape of art.

Before we lay down our pen, we may as well mention that we have now ascertained the exact date of Persius's death, viz., July 12th, 1845.

ON THE EMPLOYMENT OF COLUMNS AND PEDIMENTS AS WINDOW MOULDINGS.

"Why, 'tis a cockle or a walnut shell,
A knack, a toy, a trick, a baby's cap;
Away with it! come, let me have a bigger."
Taming the Shrew.

In pursuing the consistent development of the subserviency of decoration to utility in classic architecture, we come to a division of our subject, concerning which it is almost impossible to obtain information from authentic examples. Respecting the forms of windows adopted by the founders of classic architecture, we have little to guide us except mere surmise, for of the domestic architecture of the Greeks we are entirely ignorant, and their temples, as far as we know, were lighted exclusively by the doorways or from the roof.

The modern forms of window-architraves are derived principally from the architecture of the period of Revival, as it is called, in the fifteenth century. And notwithstanding the multiplicity of forms of window-decorations which this style exhibits, we may observe one general characteristic which distinguishes them from those of Pointed architecture. In Pointed architecture the sides of the window-opening, in the thickness of the wall, are splayed—that is, the jambs, the lintel, and the sill are not at right angles to the face of the wall, but inclined obliquely. In the splay are sunk mouldings, frequently of the most elaborate description, which constitute the principal, and commonly the only, decoration of the window. The decorations on the face of the external wall are comparatively unpretending—generally no more than a simple label or hood-moulding. It is true that as the art advanced, and especially in the last period of it, the square-headed windows were decorated with elaborate spandrels, &c. But still, as a general rule sufficiently accurate for our purpose, we may state that Pointed windows are characterized by the decoration of their splayed surfaces.* In buildings of Classic architecture, on the contrary, the decorations of the windows are almost universally in the plane of the exterior wall, and the jambs and lintel are seldom moulded or cut obliquely in the thickness of the wall.

Among the commonest ornaments of Italian windows are miniature pediments stuck upon the exterior wall, and apparently supported by consoles or by miniature pillars. There are several reasons for concluding that this use of pediments and pillars is contrary to the principles of pure taste. The most obvious reasons are that these members, when so applied, are factitious appendages, that they unavoidably have the appearance of being *stuck on*, and that they are dwarf imitations of members which always are, or ought to be, used constructively.

But it may be answered, that *all* ornaments of windows are subject to this latter objection, that they are not used constructively; that this objection necessarily applies to all decorations on the surface of external walls—to the hood-mouldings, for instance, of Pointed windows. This consideration certainly lessens the weight of the original objection when applied to pillars and pediments; so that it is impossible to consider the use of small pillars for the decoration of windows quite so flagrant an offence against good taste as the hoisting of full-sized columns to the upper story of buildings. But still, the minor fault is not excused by the existence of a greater one. To window columns is attached that sense of the ludicrous which is inseparable from diminutive resemblances of things noble and dignified in themselves. A dwarf may be extremely well formed, but no one can attribute to him the idea of *dignity*. A little column may be a symmetrical object, but it can never be a dignified one, simply because of its resemblance to architectural members, which, in all pure architecture, are made of great strength and size in order that they may perform their natural office.

A huge isolated column used to support a monumental statue, and a pigmy column used to decorate a window, are the opposite extremes of absurdity. The one has the hideous coarseness and exaggerated features of a giant, the other the ludicrous littleness of a mannikin: they should be transported to the kingdoms of Brobdignag and Lilliput respectively.

The real objection to window-columns is—not so much that they are not used constructively (for in that respect they resemble all other window decorations) as that they are copies of members which *are* used constructively. Simple mouldings like those of the *lower* range of windows in the Reform Club House may be extremely graceful and appropriate to their purpose, but window-columns have too much the appearance of caricatures: the resemblance to their prototypes is, to use the mildest term, extremely unfortunate. If window-dressings be—and they *must* be—merely decorative, it is at least unnecessary that their forms should remind us of what are by far the principal members of classic architecture—the gable-end of the roof and the columns which sustain its weight.

Imagine for a moment the same anomaly existing in Pointed architecture. Let us conceive the effect of diminutive buttresses or miniature spires stuck against the sides of the windows! Can anything more ludicrous be imagined? And yet it is very difficult to see why this degradation of the most majestic architectural forms to base uses should be more absurd in one style than in another.

It may here possibly be replied, that in Pointed architecture, door-ways, and arches of entrance (which, in many respects, fall under the same rules as windows), are decorated with series of shafts or slender columns. But this objection is entirely obviated by the consideration that in these cases the columns are not merely decorative—that they have an office to perform, and perform it; being, in fact, the imposts of arches which sustain the superincumbent masonry.

But even supposing the above considerations insufficient, what we look upon as a fatal objection to window-columns and window-pediments is the utter barrenness of invention which they display. By the adoption of them, we seem to say to the first great founders of Classic architecture, "You have given us full and explicit information on every point of your system but one—the treatment of windows. It is the only point on which you have left us to our invention; but we are unable to invent or think for ourselves, and therefore we copy over again some of your forms, and apply them in absolute indifference of their original purpose." Now this humiliating confession is all the more unnecessary, because the possibility of designing window-mouldings which are not only intrinsically beautiful but perfectly appropriate has been proved by actual example. The palaces of Italy exhibit a great number of these designs, and we have already instanced the exceedingly graceful forms of the windows of the ground floor of the Reform Club House.

We said that it was difficult to see why the application of architectural members to ignominious purposes should be more ludicrous in Classic than in Pointed architecture. And yet, perhaps, it may be easy to find a reason for this inconsistency. It is that in the one case we are reconciled by long custom to absurdities, which in the other, either never existed or have long been lost sight of. We have, in our own country, pure and genuine specimens of the skill of the Mediæval architects; consequently, we are able to study these great masters in their own language, so to speak, without the intervention of translations. With respect to the Greek architects, however, we have not these advantages; we take our notions at second-hand from the Romans, or at third-hand from the Italians, and, consequently, frequently make gross blunders from mistaking the meaning of our teachers. Mediæval architecture has now, happily, begun to be studied philosophically—that is, we are not now content with mechanically copying the *forms* adopted by the Christian architects; we study the *principles* which produced those forms. Why should it not be so with Classic architecture also? Why should the most monstrous absurdities be perpetrated daily, because we will not leave the beaten path of mere imitation, and think for ourselves?

Sydney Smith defines wit to be the discovery of a real and accurate relation between subjects, which to ordinary understandings, do not appear connected. All the great emotions of the mind and the idea of utility are inimical to wit. "There are many mechanical contrivances," says he (Collected works, Vol. I.), "which excite sensations similar to wit, but the attention is absorbed by their utility." The converse of this idea is also true; for when things to which the idea of utility is attached are, by accidental circumstance, rendered useless, they seldom fail to excite ludicrous emotions. It is for this reason that a man who is so fat that he is incapacitated from active exertion is usually an object of ridicule, and that a man confined in the stocks gets more laughter than pity. An extremely small model of a steam-engine frequently elicits from the observer a smile, which if he were to analyse his own feelings, is caused by a mental comparison of the obvious inutility of the model with the gigantic power of a large engine. Again, there is a story of some one, who in speaking of the rapid advance of the mechanical arts in modern times, suggested (perhaps rather irreverently) that we should soon have "cast-iron parsons." The absurdity of the notion evidently arises from the consideration that however much the machine might resemble the minister in outward form, there would be no hope of rendering it capable of performing the ministerial functions. Many other instances might be adduced in which the in-

* We are here, of course, speaking of ancient Pointed architecture. In some of the starved modern specimens the walls are so thin, that they do not admit of any splay.

capacity of things for the purposes which their forms suggest renders them absurd; the application of this theory to the subject of the present paper will not be very difficult.

Whatever is opposed to the principles of common sense must be opposed to the principles of good taste; and if architects have determined that they will not recognise this axiom, they will find out sooner or later that the *people*, at least, have done so. We have endeavoured on a former occasion to show why Pointed architecture is gradually subverting the Classic. Every day adds to the strength of our conviction that this tendency can only be resisted by studying Grecian architecture in the same spirit as Pointed architecture—that is, by investigating its genius and spirit. The greatest injury which it has received has been inflicted by injudicious admirers, for they have endeavoured to incorporate with it forms and ideas which can never amalgamate with it, because repugnant to its very nature. If it be not purged of these inconsistencies we may be quite certain that it will soon altogether fall into disuse. The taste of the people will pronounce for mediæval architecture, not on the ground of its abstract superiority, but because it is more philosophically studied and practised,—and unless architects will *lead* the popular taste, they will certainly be compelled to follow it.

Not that we wish to advocate the exclusive adoption of pure Classic architecture—this pure classicality is generally nothing better than insipid imitation—but what we contend against is, the affectation of classicality where there is no chance of its being successfully realised. Surely it is better to erect a building without columns at all, than to stick columns on the surfaces of the walls, here, there, and everywhere, and to jumble together columns of all sizes (and belonging to three or four different styles) in the same edifice. To look at some modern edifices, one would think that the architect had ordered his columns at so much a dozen, and that it was quite an after-thought where he should put them.

This indiscriminate predilection for columns and pediments (and the pigmy resemblances of them) is in the vilest taste. Is it quite impossible that a building can be beautiful without these appendages? On the contrary, we are not certain whether columns and pediments might not be entirely banished from domestic architecture with advantage. If *stuck on* to the front of a house, they are mere caricatures; if used according to their original and proper purpose, they generally obscure the light of the building and diminish its convenience.

With respect, however, to the more immediate subject of this paper—the form of windows—there are one or two things besides the bits of columns and pediments, which might conveniently be suffered to go out of fashion. There is, for instance, a poor contrivance for breaking the continuity of surfaces by bevilling the edges of the stone; it is, at the best, a wretched expedient. The architect has not skill enough to group his shadows in masses, and, therefore, to render the flatness of the unbroken surfaces somewhat less intolerable, he gives the masonry the appearance of being badly jointed. Cognate to this flimsy artifice is that of scoring in the surfaces of the stone deep irregular channels which give it the appearance of being worm-eaten. This kind of masonry receives the gentle appellation of "rustic masonry,"—we should have thought "tattooed masonry" a more appropriate term. Fancy the Parthenon thus gashed and cicatrised!

Another practice in the construction of windows is the placing them so that the architraves intrude upon the frieze of an order, the continuity of which is broken to make way for the intruders. This practice is so evidently indefensible that it is not necessary to waste argument upon it. The fault is happily not very prevalent, but if the reader require an instance, we will refer him to the cathedral church of St. Paul.

The last solecism we have here to notice, is the construction of sham-windows (and also of sham-doors, for most of the rules respecting windows are applicable to doors). These, like other shams and pretences, generally reveal their own dishonesty. The architect who makes use of these expedients reflects far more severely on himself than the strictest critic could, for he confesses that he has managed his design so badly that, for the sake of uniformity and symmetry, he ought to make more windows than the purpose of the building requires, and that he has no better way of getting over the difficulty than by building sham windows in places where it is either unnecessary or absolutely impossible to construct real ones.

With respect to these and all other artifices and make-beliefs, we have one safe and certain rule to guide us—architecture is not a system of artifices. Its claim to elevated rank among the fine arts rests on much higher and nobler principles than those of trick and show. But there is now, unhappily, in all the fine arts a fashion for imitation, which is diametrically opposed to true artistic feeling. In painting, we have minute resemblances of leaves, fruit, or the pattern of silk and embroidery. In sculpture, sublimity of general expression is thought less important than accuracy in chiselling each particular hair, vein, or wrinkle of the skin. In music, we have clattering railway overtures, crashes in the base to represent thunder, and runs in the treble to imitate the nightingale. And in architecture, we must have stone look like lace, and iron like stone; we consider it imperatively necessary that every material which we use should look like something else than what it really is—above all we prefer the foppery of sticking on a few bits of finery here and there to the harmony of composition, the due disposition of light and shadow, the adaptation of every member to its appropriate office, and that general dignity which results rather from the conscious possession of beauty than the ostentatious display of it.

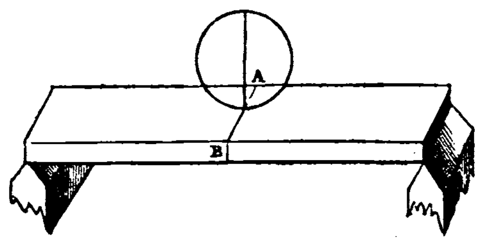
A NEW THEORY OF THE STRENGTH AND STRESS OF MATERIALS.

By Oliver Byrne, Professor of Mathematics.

I do not intend to occupy much space or time in dilating on the importance of my subject, or in giving a history of its rise and progress, or in making apologies when I differ from my predecessors, however instructive, entertaining, or judicious an opposite procedure may be; but when I do differ, I will give my reasons for doing so without a circumlocutory apology.

Theory tells us that if a uniform bar—no matter what the figure of the cross section may be, or what substance it may be composed of—be suspended by one extremity, and loaded at the other till it is on the point of being torn asunder, the weight and the corresponding transverse sectional area are proportional. The bars or rods compared requiring only uniformity and equality of texture, we may lay down a general law, *the lateral resistances* (in the direction of a perpendicular to the transverse sections) *are in proportion to the areas of these transverse sections*. This law is very evident, for if a bar or rod were conceived to be longitudinally divided into any number of equal strips, no reason could be assigned why one of these strips should support a greater portion of the weight than any of the others, so that each would support an equal part of the weight, in the same manner as an assemblage of equal parallel ropes divide the weight of an appended body equally among them. Experiments on lateral strains prove these deductions to be correct, and it affords an instance in which theory and practice may be said to coincide. The contrary is the case when the beam or bar is supported in a horizontal position, for then, the law of resistance, opposing fracture by an incumbent weight or force, is more difficult to establish, because we do not so readily see how the resisting forces exert themselves. Unlike lateral strains, the discrepancy existing between the results given by theory and by experiments is very great indeed; so much so, that very little can be relied on the theoretical results that are beyond the range of experiments. Indeed, with experiments of a range sufficiently extensive, no very great mistake can be made, however loose and uncertain the theory may be; but when we require a step far beyond our experiments, such as the determination of the best form and dimensions for a tubular bridge like that proposed by Mr. Stephenson, then the want of a theory, supported by experiment is a very great requirement.

Fig. 1.

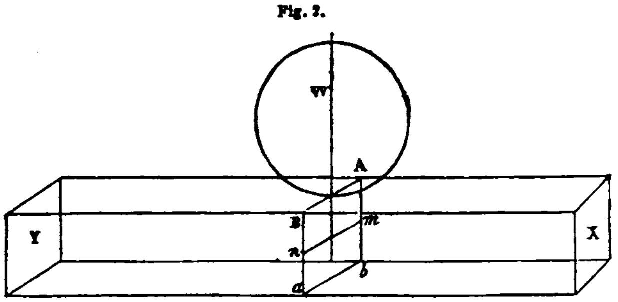


Galileo was of opinion that if a beam were supported at its extremities, as in fig. 1, and loaded by a weight at the middle, that all the fibres or filaments would exert equal resistances to prevent fracture, and that when these were overcome the whole would tend to turn about that boundary A B, in contact with the weight.

As this view of the subject supposes all the fibres to exert equal resistances, and in the direction of their lengths, these resistances will be so many equal and parallel forces and may be considered as acting together in the centre of gravity of the section, so that denoting the resistance of a single fibre by f, and supposing the section to be a rectangle of breadth b, and height h, then will $f\,b\,h$ express the sum of the resistances, and as this acts at the centre of gravity of the section, which is at the distance of $\frac{1}{2}h$ from the line A B, its moment to turn about A B will be $f\,b\,h \times \frac{h}{2} = \frac{f\,b\,h^2}{2}$.

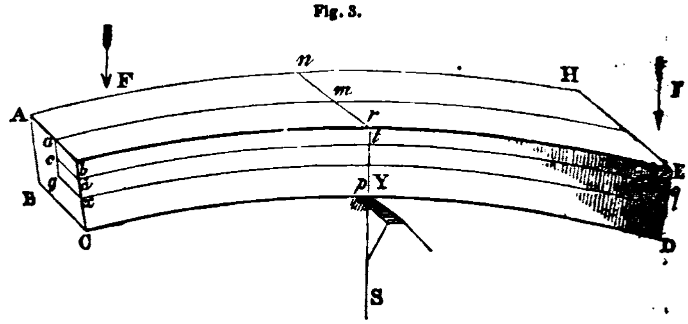
Leibnitz gave another hypothesis, which agreed with that of Galileo with respect to the position of the axis about which the segments would turn. But Leibnitz supposed the filaments or fibres to exert forces proportional to their distances from the axis; so that the middle fibre, according to the theory of Leibnitz, exerted but half the force of the extreme fibre. Calling the force of the extreme fibre f, the sum of the forces would be $\frac{f\,b\,h}{2}$; and since the centre of such a system of parallel forces is at the distance of $\frac{2h}{3}$ from the axis about which the whole is supposed to turn, hence the moment to turn will be expressed by $\frac{f\,b\,h}{2} \times \frac{2h}{3} = \frac{f\,b\,h^2}{3}$. It is easily seen, that, as far as regards the comparative strength of rectangular beams of the same material, or of similar beams whose transverse sections are rectangular, it is no matter which of these hypotheses be adopted, for both point out the law of resistance to be as the breadth multiplied by the square of the height; we shall in future use the term height or depth for the dimension in the direction of the pressure.

Fig. 2.



Galileo and Leibnitz supposed that the segments of a beam X Y, fractured by a weight W, turned about the line A B where the fracture terminates. But James Bernoulli, Mariotte, and others, were of opinion that the segments had a tendency to turn about a line, as $n\,m$, entirely within the section; the fibres on that side of the line where the fracture begins are extended, and those on the other side compressed. If the beam X Y, resting on two props at X and Y, be fractured by the weight W and $m\,n$, the line inside of the section A B $a\,b$, about which the segments of the beam have a tendency to turn, then the fibres or filaments in the space $n\,m\,b\,a$ are supposed to be extended, and those in the space B A $m\,n$ compressed. The imaginary line $m\,n$, which divides the section A B $a\,b$ into two parts—the area of compression and the area of tension—is called the neutral axis. Mr. P. Barlow laboured much to find out the true position of this neutral axis in different sorts of timber. The result of his labours and experiments may be summed up in the following words, the truth of which is very questionable:—"The centre of tension and the centre of compression each coincide with the centre of gravity of its respective area (?) and the neutral line which divides the two is so situated, that the area of tension into the distance of its centre of gravity from the neutral axis is to the area of compression into the distance of its centre of gravity from the same line, in a constant ratio for each distinct species of wood, but approximating in all towards the ratio of 3 to 1." (?) It would take up too much space to dwell on the absurd conclusions of Mr. Barlow; there are one or two things which require but little consideration to detect, first, the neutral fibres do not arrange themselves in a right line in all forms of beams, indeed, if such a line did exist, it would be a curve governed by the external form of the beam and the force applied. In the second place, the centre of gravity cannot agree in all cases with the centres of the forces of the filaments of the compressed and extended areas, and any man at first sight might suppose that the areas of compression and tension would bear a constant ratio to each other in each distinct species of wood. In the third place, I defy experiment either to confirm or contradict these conclusions of Mr. Barlow, for they have nothing whatever to do with the strength of beams. He merely says, find where MY LINE is by experiment, and I will give you something like the result of experiment from a line so determined. Let x Y Z be a portion of a beam in the locality of fracture, caused by the forces F F acting in the directions of the arrows. The same process of reasoning which points out a neutral axis in the whole A H D C, will point out a neutral axis in any portion of the body $g\,a\,b\,x\,t\,g$, no matter where it be situated; in fact, every fibre may be said to be compressed on one side and extended at the other, while the whole or each is bent round a common centre, as S, entirely outside the body. Then S Y is the radius of curvature of the arc C P D at the point p.

Fig. 3.



Now let us take $g\,c\,d\,x\,t\,y\,q$ Z, any portion of the beam, it is evident that the filaments in the upper part near to $d\,t\,q$ are expanded, and those near to x Y Z are compressed; according to this reasoning there is a set of fibres between $d\,t\,q$ and x Y Z which are neither compressed nor expanded; hence each portion of the beam is entitled to a neutral axis, which is relatively correct, but each neutral axis is itself bent round a centre in r S.

It is stated by Tredgold ("Practical Essay on the Strength of Cast Iron," page 53),—"When a rectangular beam is supported at the ends, and loaded in any manner between the supports, it may be observed that the side against which the force acts is always compressed, and that the opposite side is always extended; while at the middle of the depth there is a part which is neither extended nor compressed; or, in other words, it is not strained at all.

"Any one who chooses to make experiments may satisfy himself that this is a correct statement of the fact, in any material whatever, whether it be hard and brittle, as cast iron, zinc, or glass; or tough and ductile, as wrought iron and soft steel; or flexible, as wood and caoutchouc; or soft and ductile, as lead and tin. In very flexible bodies it may be observed by drawing fine parallel lines across the side of the bar before the force is applied; when the piece is strained, the lines become inclined, retaining their original distance apart only at the neutral axis." Now this fallacious statement (first made by M. Mariotte, which Mr. Barlow and a host of others down to Mr. Mosely have endeavoured to support by experiments, conjectures, and assertions,) may be exposed in the following descriptive manner, and afterwards by a mathematical investigation. Suppose X Y, V W, and Z T to

Fig. 4.

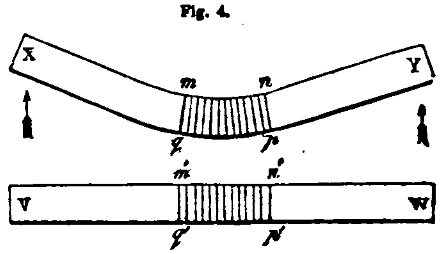


Fig. 5.

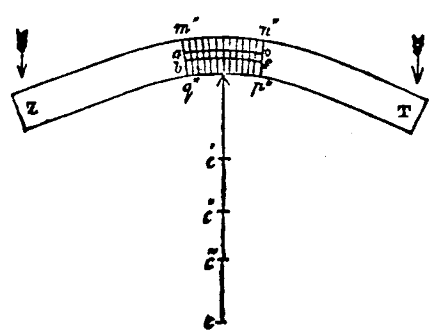


Fig. 6.

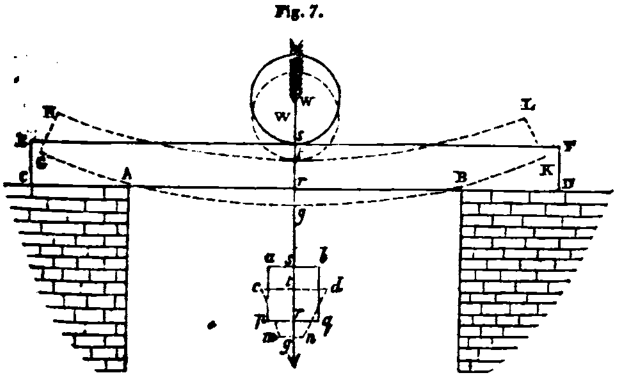
be the same beam under different circumstances. If a beam Z T be strained, with parallel lines drawn as above directed, at $m'' n'' p'' q''$, the very fact, that the line $b\,s$ being bent, shows that its particles are not in a state of quiescence, although it may be the same length as $m'\,n'$, or that one of the subdivisions of $b\,s$ is equal to one of those in $m'n'$, the position of the beam before it is bent; as Z T becomes more and more bent, the divisions will open in the upper regions near $m''\,n''$, and more contracted towards the lower near $q''\,p''$, so that the position of the neutral axis must shift towards the lower part of the beam from the top, unless the curves $m''\,n''$ and $p''\,q''$ be arcs of concentric circles, then the arc $s\,o$ in the centre will always be equal to $m'\,n'$. But it is not evident that the particles in the arc $s\,o$ or $b\,s$ are not strained at all, because either of them happen to be of the same length as $m\,n$, $m'\,n'$, or $m''\,n''$, which were all equal before the forces were applied

The conclusion we come to here is, that the whole turns round an axis, sometimes outside of the body and sometimes inside, according to the position of the centre of the circle of curvature of the curve where the greatest strain is applied. Let c' be the centre of the circle of curvature of the point in the centre of the arc $q''\,p''$, then that arc is supposed to be strained round c' as an axis. Let c'', c''', and C be respectively the centres of the circles of curvature for the points in the middles of the arcs $b\,s$, $s\,o$, $m''\,n''$; then the arc $m''\,n''$ is supposed to be bent round the centre C; $s\,o$, round c'''; and $b\,s$ round c''. When the filaments that are the most expanded—that is, those near $m''\,n''$ in Z T, and near, $q\,p$ in X Y,—become flatted at the centre, between m'', n'', or between $q\,p$, which is generally the case before fracture ensues, then the centres of the circles of curvature at these centre points, after changing from C to c''' to c'', &c., as the beam Z T becomes more bent, now returns in a contrary direction, c, c', c''', &c.; and when the fibres in $m''\,n''$ become straight, the radius of curvature becomes infinite, as in the case of the beam V W at rest, in which the particles or fibres at $m''\,n''$ are supposed to be straight.

We shall next consider the nature of the forces exerted by the filaments at different points of the cross section, in the region where fracture would ensue, when the strain exceeds the elastic limit of the body.

The beams or bars, the nature of the cross sections of which we are investigating, are supposed to be supported at the ends and loaded in the middle. In small beams, the change in the particles that we are about to describe is not perceptible; yet it will be found very considerable in large girders, such as the tubular bridge about to be constructed by Mr. Stephenson, or in small girders of a flexible nature.

Fig. 7.



The figure used in elucidating this matter is distorted, in order that the change under consideration, near the centre of the beam, may be more apparent. A very simple mode of illustrating what we shall describe relative to the molecular action of the particles in a cross section, near the centre of the beam, may be obtained by taking a rectangular piece of caoutchouc, whose cross section would be represented by $a\,b\,q\,p$; but, it is to be understood, that in point of structure we do not compare caoutchouc or india rubber with iron, brass, or wood;—but, merely to show the manner in which the particles in the cross sections of bodies, under the circumstances we have just described, endeavour to exert themselves. Let E C D F be the position of a beam before the weight W is applied,—H G A B K L its position after; the cross sections in the two positions will be represented by the figures $a\,b\,q\,p$ and $c\,d\,n\,m$. The action of the weight or force W compels the point s to move to t, and the point r to move to g, and has a tendency to lengthen the whole beam; while at the same time, the filaments in the upper part of the beam, near the middle, become compressed in the direction of the length A B, and extended in the direction of the breadth $a\,b$; that is, the breadth $a\,b$, in one position, is represented by $c\,d$ in the other. But the fibres in the lower part near r, in changing from r to g, become expanded in the direction of the length A B, and contracted in the direction of the breadth $p\,q$, so that $p\,q$ in the cross section becomes $m\,n$. From the rigidity of materials, this change may not have place, or may not be perceptible; but, in all cases, a force acting in the direction of the arrow will have the tendency to change the cross section $a\,b\,q\,p$ into one like $c\,d\,m\,n$, which if it be not able ultimately to effect, fracture must ensue.

As we have before observed, what we have just described will become clear by bending a rectangular piece of india-rubber. If the section of the rod or beam be circular, as Z, the change will differ materially from the one already described, for the circle will become, or endeavour to become, a figure like an oval. The change in the molecular particles in the cross section will arrange themselves differently, according to the external forms of the beams and the positions in which they are placed: something like the change of form in triangular beams are given in the figures X and Y. When the strain is about to exceed the limit of the

Fig. 8.

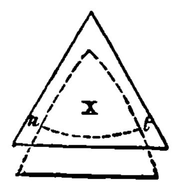
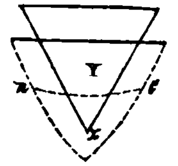


Fig. 9.



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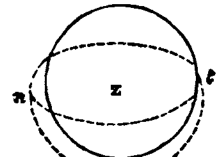
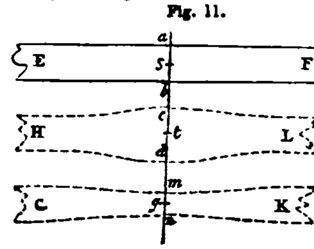


elastic power of the material, the fibres which are in a state of quiescence, compared with those in the extreme upper and lower regions of the beam, will arrange themselves in a curve resembling $n\,t$ in the figures X, Y, and Z, the equation to which will be given hereafter. The behaviour of the force and filaments here stated are in themselves sufficiently simple and explicit, but, in order that none of our readers may enter upon the mathematical investigation of this important subject with incorrect notions respecting the different circumstances under which the beam may be placed, we have thought it expedient to add the following expositions and illustrations:—

Fig. 11.



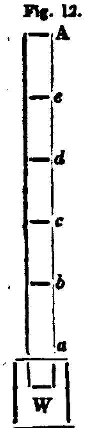
Let E s F be the upper or lower surface of the beam before the weight W is applied; H t L will represent the upper, and G g K the lower, after its application. The same parts are marked with the same letters as the figure preceding, for these surfaces are supposed to have reference to that figure. If the particles at $a\,s\,b$ in the bending process were such that they would merely become more dense, then the breadth at $a\,s\,b$ would not be changed; but it is not the case, for the harder parts of the material merely obtrude themselves into the softer, and partly become compressed and partly swell the breadth of the beam near these parts, as at $c\,t\,d$ in the upper section H t L. But in the lower surface G g K, or near it, the pariicles at $m\,g\,n$ become separated, and the breadth becomes contracted from $a\,b$, which is equal to $p\,q$ to $m\,n$.

We shall in the next place proceed to the mathematical investigation. Let W be the weight in pounds that would be borne by a beam of wood, iron, or any other material, whose cross section is an inch square, when the strain is as great as it will bear without destroying the elastic force of the body, and the direction of the force coincident with the length or axis of the bar; and let W′ be any other weight to be supported under the same circumstances. Suppose the cross section of the piece to support it to be a rectangle, whose breadth $= x$ and thickness $= y$ inches.

Then $W : W' :: 1 : xy$; or, $\frac{W'}{W} = xy$.

Strictly speaking, the lengths must be the same, or W and W′ must include the weights of their respective beams. This proportion has place from the well-known principle—abundantly proved by experiments—that "the strength of a bar or rod to resist a given strain, when drawn in the direction of its length, is directly proportional to the area of its cross section; while its elastic power remains perfect, and the direction of the force coincides with the axis."

Fig. 12.



Let d be the quantity a bar of iron, or other material, an inch square, and a foot in length, represented by $a\,b$, would be extended by the force of the weight W in pounds, which, as in the last, is supposed to be the greatest, it would bear without destroying its elastic force; and let L be the length of any other portion of the same rod in feet.

Then $1 : L :: d : L\,d =$ the extension of the rod, whose length is L. This is evident, for if we suppose the weight W to be attached at a, and to stretch $a\,b$ a quantity d it will stretch $a\,c$, $2\,d$; $a\,d$, $3\,d$; &c., because W, after stretching $a\,b$, will apply the same force to $b\,c$, and, strictly speaking, a little more, for it will have an additional weight in the length $a\,b$, a foot of the material; the same reasoning will hold with respect to any other foot, as eA for the weight W, and the weight of 4 feet of the material may be supposed to be applied at e, and act in expounding eA, but the weight of the rod is so small, that it may be neglected in moderate lengths. Strictly speaking, then W, the ultimate force must involve the weight of the bar to which it is applied. The weight W would ultimately be reduced to zero, for the bar would only be able to support its own weight without destroying its elastic force.—Example: cast iron will bear, without permanent alteration, 15,300 lb. upon a square inch; consequently, the length of a rod of cast iron that would be just able to support itself without permanent alteration would be 4,896 feet; a cubic foot of cast iron weighs 450 lb., no matter what the cross sectional area may be. Again, suppose W′ to be any other weight less than W,—

$W : W' :: d : \frac{W'd}{W} =$ the extension produced by the weight W′, supposing the length to be one foot, and the cross section an inch square; and also that the extension of a bar or rod by a force acting in the direction of its length, is proportional to the straining force; the area of the cross section remaining the same, and the strain not to exceed the elastic power of the beam, bar, or rod.

The extension for any length L, by the weight W′, $= \frac{L\,W'\,d}{W}$; for, $1 : L :: \frac{W'd}{W} \therefore \frac{L\,W'\,d}{W}$.

W′ is supposed to involve the weight of the bar, as well as W.

Let it be required to the elongation E of a bar suspended vertically, and sustaining a given strain or weight W, in the direction of its length equal L feet, the influence of its own weight being taken into account, the sectional area A square inches. Without destroying the elasticity, or surpassing the elastic limit, suppose ϵ to be the length that w pounds will elongate a bar weighing p pounds, one foot long and one square inch sectional area.

Suppose the last foot of a bar L feet long to be suspended to the second last, the effect of the last to elongate the second last will be found by the following proportion:—$w : p :: \epsilon : \frac{p\,\epsilon}{w} =$ the elongation of the second foot.

Suppose these two feet to be attached to the third foot, we have $w : 2p :: \epsilon : \frac{2\,p\,\epsilon}{w} =$ elongation of the third foot; $w : 3p :: \epsilon : \frac{3\,p\,\epsilon}{w} =$ elongation of the fourth foot; therefore the sum of the following series will give the whole elongation, the length of the bar L representing the number of terms, we have $\frac{p\,\epsilon}{w}\left\{1+2+3+4+\ldots.\ L-1\right\}\times\frac{L}{2}=\frac{L^2 p\,\epsilon}{2\,w}$. Or the elongation may be determined thus:—Let x be the length in feet measured from the lower extremity, then $w : p\,x :: \epsilon : \frac{\epsilon\,p\,x}{w} =$ the elongation of a foot in length from the strain of the weight $p\,x$. And let $d\,x$, as writers on the Calculus say, be the length which is next to nothing. $\therefore \frac{\text{foot}}{1} : \frac{\text{feet}}{d\,x} :: \frac{\epsilon\,p\,x}{w} : \frac{\epsilon\,p}{w}\,x\,d\,x =$ the elongation of the length which was supposed to be next to nothing. Integrating between the limits $x = o$ and $x = L$; that is, $\int_o^L \frac{\epsilon\,p}{w}\,x\,d\,x = 2\,w\,\frac{\epsilon\,p}{w}\,L^2$. So that a bar 1 inch square and L feet long will be elongated by its own weight $\frac{p}{2\,w}\times L^2\,\epsilon$; indeed, let the sectional area be what it may, the bar will be elongated by its own weight the same length, because the body is uniform, and each inch of sectional area is circumstanced in the same manner.

The number of pounds on each square inch of cross section $= \frac{W}{A}$, together with the weight of the bar up to that section. Then just at the point where the beam is suspended, there will be $\frac{W}{A} + p\,L$ pounds on the square inch, which must not exceed w, the elastic limit in pounds for each square inch of section. $w : \frac{W}{A} :: \epsilon : \frac{W\,\epsilon}{A\,w} =$ the elongation of each foot in length by the weight $\frac{W}{A}$ on the square inch; but as each square inch is strained by the same weight, each foot of the bar will be increased by the same length. $\therefore \frac{W\,\epsilon}{A\,w}\,L =$ the elongation of the length L, by the weight W. And hence, $\frac{W\,\epsilon}{A\,w}\,L+\frac{p\,\epsilon}{2\,w}\,L^2 = L\,\frac{\epsilon}{w}\left\{\frac{W}{A}+\frac{p}{2}\,L\right\} =$ E, the elongation by the weight W and L A p the weight of the bar.

We shall next explain certain numbers introduced by writers on this subject, and called by them *moduli*. There is the *modulus* of elasticity, the *modulus* of resilience, the *modulus* of fragility, and the *modulus* of rupture.

The *modulus of elasticity* is the strain in pounds which would be required to extend a bar, one foot long and one square inch sectional area, to double its length without altering its sectional area; or it is the trust in pounds that would compress the same unit bar into half its length, that is, till the foot becomes 6 inches, the sectional area remaining, as before, one square inch. We never could see the real use of introducing these imaginary numbers, unless for the purpose of mystifying the subject or to make it assume a very scientific appearance.

It would be a stretch of the imagination to suppose a brick to be pulled till it would become the length of two bricks. He must be a very clever man indeed who determined the modulus of elasticity of pipeclay. Mere book-makers like Hall and Moseley, of King's College, cannot be offended; but men like Barlow and Hodgkinson, who have lost their time experimenting to find them, may be a little indignant to find their favourite numbers spoken so lightly of.

Let us suppose, for argument sake, that Tredgold is right with respect to the modulus of malleable iron; he found the modulus of elasticity to be 24,920,000 lb., or 7,550,000 feet of the same matter; sectional area one square inch. Those who have made experiments will give but little credit to one who finds him wrong. Tredgold found that 17,800 lb. on a square inch of good English iron would cause no permanent alteration, and would extend a foot or any other length, not taking into account the weight of the bar, the $\frac{1}{1400}$ part of its length. $\frac{1}{1400}$ in this case would be ϵ, $17800 = w$, and $p = \frac{475}{144}$, for a cubic foot of malleable iron weighs 475 lb. nearly. Now it is evident, if the elastic limit of malleable iron were such as to allow it, and that the elongation was in direct proportion to its strain, that it would require 1400 times 17,800 lb. to extend this foot of iron till it becomes two feet long, or, which is the same thing, till it becomes a foot elongated. Now 1,400 times 17,800 = 24,920,000 lb., or, $17{,}800 \div \frac{1}{1400} = 24{,}920{,}000 = \frac{w}{\epsilon}$; this, to make the matter assume a learned appearance, or rather, a more college appearance, we shall represent by M_e; the modulus of elasticity and its reciprocal $\frac{\epsilon}{w}$ by $\frac{1}{M_e}$; so that $E = L\,\frac{\epsilon}{w}\left\{\frac{W}{A}+\frac{p}{2}\,L\right\}$ may be written $E = \frac{L}{M_e}\left\{\frac{W}{A}+\frac{p}{2}\,L\right\}$. A bar of malleable iron, one square inch of sectional area and 7,550,000 feet—nearly 1,430 miles long = 24,920,000 lb; from which circumstance 7,550,000 feet is called the modulus in feet; $24{,}920{,}000 \div \frac{475}{144} = 7{,}550{,}000$. That is, $\frac{w}{\epsilon} \div p = \frac{w}{p\,\epsilon} = M_e \div p$; in this modulus Hodgkinson differs 400 miles of iron from Tredgold, and Barlow about 250 miles of iron from Hodgkinson. So much for the modulus of elasticity.

The elongation of a bar suspended vertically, and sustaining a strain of W lb.—the influence of its own weight not being taken into account—was found to be $\frac{\epsilon}{w}\cdot\frac{W\,L}{A}$, which we shall call l:—

$\therefore l = \frac{W\,L}{M_e\,A}$ by substituting for $\frac{\epsilon}{w}$ its value $\frac{1}{M_e}$. Before we explain what is meant by the *modulus* of resilience or fragility, it is necessary to say what is meant by a unit of work. A pound weight raised vertically one foot is a unit of work done. A spring that lifts 1000 pounds $\frac{1}{1000}$ part of a foot does a unit of work. It is evident, that to elongate a bar an additional length l, the weight necessary to keep it elongated needs not be applied from the commencement of the process of elongating; for half l would be produced by half the weight, and one-third of l by one-third the weight, and so on. It is evident that $W\,l$ would be too much, for the weight W would not be actually employed in the business of elongation in moving from o to l.

Let L be the length of the bar before the weight W is applied; A, the area of its cross section; as before, $l =$ elongation consequent on W. And let x be any elongation between o and l. The weight necessary to keep L stretched to $L + x$ will be $\frac{x}{l} \times W$; this weight may be said to be fully employed while it passes through dx at the very extremity of $L + x$. $\therefore \frac{W}{l}\,x\,dx$ expresses the work done; $\therefore \frac{W}{l}\int_o^l x\,dx = \frac{W\,l^2}{2\,l} = \frac{W\,l}{2}$, the whole units of work.

We have shown that $l = \frac{W\,L}{M_e\,A}$ $\therefore M_e\,A\,l = W\,L$

$$\therefore W = \frac{M_e\,A\,l}{L} \quad \therefore \frac{W\,l}{2} = \frac{M_e\,A\,l^2}{2\,L} = \text{the units of work.}$$

Also, the work done, or the resistance overcome, expressed in units of work, $= M_e\,\frac{A\,l^2}{2\,L} = \frac{1}{2}\,M_e \left(\frac{l}{L}\right)^2 L\,A$; hence it is evident that the amount of work to be done to elongate different bars of the same material, any fractional part of its length expressed by $\frac{l}{L}$, which must not exceed the elastic limit, will vary as L A; for in every case $\frac{1}{2}\,M_e \left(\frac{l}{L}\right)$ remains constant. The work done in elongating a bar to its elastic limit,

(To be continued.)

FITZWILLIAM MUSEUM.

The following particulars respecting the site and purpose of this noble building may be interesting to those readers who are not acquainted with the topography of Cambridge.

The situation of the Museum is one of the most favourable which an architect could desire. It is near the entrance of the town from the London road, in a broad open part of the main street. When first erected the building was hemmed in by several mean and decayed tenements which have since been removed. The edifice is now perfectly isolated: on three sides are broad spaces of lawn, on the fourth or principal side is the open thoroughfare, So that the architect has had the advantage of placing his building where it may be readily seen, and where it is the conspicuous object of a place of public resort, without the architecture being marred or concealed by the adjacent houses.

The material of the masonry, pure white Portland stone, contributes much to the architectural effect—and especially in summer by the contrast of the dazzling colour of the building with the dark foliage of the trees in Peterhouse gardens. The whiteness of the stone is really extraordinary, and generally gives to strangers the impression that the building is constructed of pure marble. Those who are merely accustomed to see Portland stone of the colour which it assumes in the smoke of London, can scarcely imagine the almost startling effect produced by the brilliant appearance of the Museum at Cambridge, when seen for the first time: there are few strangers who on entering Cambridge are not impressed with a feeling akin to amazement when they suddenly come in sight of this gorgeous monument of classic architecture. The effect by night, especially, when the moon is shining, is very striking. The columns show in the moonlight as white as snow, and there is something almost magical in the manner in which they contrast with the dark shadows of the surrounding trees.

It must not be supposed, however, that the whole of the effect is to be attributed to the accidents of situation and colour: these serve only to exhibit fully the excellence of the architecture. It has been Mr. Basevi's good fortune to place his masterpiece where it will be seen and appreciated by men of taste and education; and it has successfully undergone the ordeal of their criticism. This ordeal is the more severe, because, as most of the readers of the Journal are aware, there is in Cambridge a strong and energetic party of amateur architects whose exclusive tenets would lead them to regard with little favour such a building as the Fitzwilliam Museum. Even from the hands of these, however, its architectural character has escaped safely. The most zealous of the Camdenists will generally allow (in moments of candour and liberality) that the Museum is on the whole an exception to the usual hideousness of Pagan architecture; and some of them have gone so far as to say that the building exhibits positive merits, and that they look upon the lofty columns and the sculptured pediment not only without disgust, but with a feeling very like absolute satisfaction.

But the Fitzwilliam Museum has undergone a test even surer than the judgment of the members of the Camden Society. The test is this—that the architecture appears more beautiful as the eye becomes more familiar with its character. There are many buildings which appear well at first sight, which cease to please on a second inspection; but this is by no means the case in the present instance. If on his first visit to the Museum, the stranger be gratified by the boldness and richness of its architecture, his pleasure will be only increased in subsequent examinations, when he begins to criticise the architecture in detail. Perhaps no one feels a greater admiration of it than the old Cambridge man after having been familiar with the building during the whole time of his residence, examines it afresh after the interval of several years.

That the architecture is not perfect it is useless to deny. The square mass or *hump* which rises above in the rear of the pediment sadly injures its effect, and this injury appears far greater on actual inspection of the building than could possibly be supposed from an examination of a view of the elevation. The *reason* of the injury produced probably occurs to few, though all are able to pronounce as to the reality of it. There can be no doubt that this reason is to be found in the fact that the rules of "apparent construction" are violated. The pediment, instead of being, as all pediments should be, the gable end of a roof, assumes the appearance of a factitious appendage—it looks *stuck on* and not an integral and essential portion of the structure. This effect is certainly produced by the "hump" in question, which destroys all idea of the continuity of the roof. To the same cause must be assigned the disfigurement produced by the lateral wings flanking the portico. This criticism rests not merely upon an individual opinion—the defects to which it refers are universally condemned by those who are familiar with the building. The superstructure above the apex of the pediment, and the wings to the right and left of the portico are equally destructive to its character—and from the same cause:—they show that the portico is not treated constructively, but is merely an ornament—an appendage.

There is a phrase among sculptors for a group of which the several parts are not sufficient separated—they say of such sculpture that "it does not show enough day-light," and the cutting away the marble so that limbs appear distinct and the light shines through in different parts of the group is called "letting in day-light." To apply this phraseology to a portico which like that of the Fitzwilliam Museum is flanked by wings—it excludes too much light. In pure architecture such as that of the Parthenon, the Temple of Theseus, or that of Neptune, at Pæstum, a most beautiful effect is produced by the light shining in between the extreme columns of the portico and the angles of the cella.* The relief thus given by the corner columns standing out distinctly against the sky or background is necessarily lost in the Fitzwilliam Museum.

It may also be fairly objected that the character of the street front of this edifice is not maintained in the other sides of it. Not indeed that we accuse the architect of masking it with a "show front:"—that utter violation of the rules of architecture—that hopeless vulgarity of taste, was reserved for our two national repositories of works of art, the British Museum and the National Gallery. Of these buildings the less conspicuous sides have about as much architectural pretension as a factory or union-workhouse, being in fact built of the plainest brickwork, so that the show sides, even if they were tenfold better than they really are, must be pronounced absolutely devoid of artistic value. It is however but fruitless labour to criticise these monuments of perverted taste; they display that entire want of all true architectural feeling which renders animadversion obviously useless, and we merely notice them to institute a contrast in favour

* One of the very few good qualities of the architecture of Buckingham Palace, is that the columns of the pediments at the wings stand out in this manner. The only other merits, and they are but negative merits, of this building, are that the pediments at the hump are treated as gables, that the building has not a show side, and that the materials of the masonry are all real.

of another museum of art, which though situated in a provincial town, and built neither by the national wealth nor under the auspices of the government, is the only one of the three worthy of the high purpose for which it was designed.

Of the architecture of the other parts of the building, besides those exhibited in our drawings, it must be allowed that though not absolutely bad in themselves, they by no means correspond to the elaborate magnificence of the portico. This is the more to be regretted, because from the nature of the site the sides of the Museum are quite as conspicuous as its front, and the observer can never approach it without being made aware of the disagreeable contrast. The elevation next Peterhouse Gardens has the most architectural pretension, and it, as well as the sides, are of the same beautiful stone as the front; but still the surfaces appear comparatively flat and unbroken; and what is perhaps even of more consequence, the few ornaments displayed by no means correspond in purity of taste to the character of the portico.

The interior of the building is still in a very unfinished state; the completion of it is assigned to Mr. Cockerell, and it is earnestly to be hoped that the decorations will be as *real* as possible, and that there will be no attempts to make plaster look like stone or cast iron, and deal boards look like oak. The building when completed will hold the statues, pictures, cameos and engravings bequeathed to the University by the Earl of Fitzwilliam, and also another very valuable collection of pictures at present in the Pitt Press.

ARCHITECTURAL RECOLLECTIONS OF ITALY.

By Frederick Lush.

From some ornaments taken in Italy I select the accompanying sketches for your Journal, on account of their beautiful forms, and because they might serve as a model for our English knockers, or at least suggest a more graceful and pleasing feature than that which is generally placed

Fig. 1

on our doors. Figures 1 and 2 are from Venice, but most probably of Florentine workmanship, and fig. 3 is from Verona.

Whoever has seen these small though magnificent objects abroad, must have felt how much they ennobled the entrances of the old palaces, and how delightful it was to linger on the threshold and admire them. It is strange that in England, where within the last few years so much has been done to improve every kind of decoration, these things have been neglected as though they were considered beneath the notice of the artist. The names of such men as Ghiberti, John of Bologna, Benvenuto Cellini, and others, who have left us their beautiful works, along with larger ones, could not suffer such an opinion for a moment to be entertained; but it is well known, as in the examples before us, the beauty and picturesque effect which is infused into the smallest things when genius has laboured upon them. In the design of these knockers, as well as in everything

Fig. 2.

else which passed through the hands of these cunning goldsmiths and industrious sculptors, there is an elaborate finish, of which they are quite worthy, and which for the most part challenges the closest inspection.

Fig. 3.

Leaf, flower, bird, or figure, were executed with so much feeling, and such truth to nature, that even the simplest articles of common use or ornaments in dress were real works of art; nor could a censer, salver, goblet, or a crucifix, that was fashioned by the same hand as that which wrought the Perseus, be otherwise than a gem in the collection of a prince or in the cabinet of the virtuoso.

The high opinion conceived by the Italian artists of the humblest department of art; the intense care and industry bestowed on small things as well as great; and their associating together in one common brotherhood, where none was excluded from the rest, were circumstances which acted most happily towards the development of taste and the perfection of the arts, and of which Lanzi speaks in his history of the Italian painters. The result of these ideas and the strength acquired by this union is epecially evinced in Italy. Common objects, which in Britain seldom receive any attention, there reveal some striking artistic beauty. It is sufficient in addition to what has been already referred to, to mention the famous lampholder in the Strozzi palace, Florence; the dolphins and sea-horses sculptured on the top of the tall mooring-posts in Venice; the lanterns on her canals; the ornaments of the Ca' d'oro; the pedestals to the Grecian standards in the Piazza di San Marco; or the bronze cisterns in the quadrangle of the Ducal palace.

ROYAL ACADEMY EXHIBITION: ARCHITECTURE.

We will not disturb the opinion which attributes improvement to the present Exhibition as far as the painters are concerned,—although for our part we do not perceive the slightest general advance at all,—but matters have most assuredly not mended this season with regard to architecture. However, we are tired of repeating the same complaints year after year, and that to no purpose. The Academician architects take pattern by Sir Robert Smirke, and their quality brethren take pattern by them, therefore from those who, it is to be presumed, could show us most, we get least; nor have we much from other quarters to inform us what is going on in various parts of the country. Liverpool, Manchester, and many other important places are wholly unrepresented in the present annual parliament of art in Trafalgar Square. Where are all the things whose fussy "first-stone-laying" ceremonies are recorded with such "wink o' the eye" admiration by newspapers? Where, all those drawings which have borne off five and ten pound premiums from liberal and self-enlightened competition committees? We see them not here: but to speak of what we do not see would be a much longer tale than to enumerate what we do find, that either deserves commendation or is worth mention. In an exhibition of architectural drawings we have a right to look for interest of some kind—either that attending designs adopted or proposed for particular buildings, be the talent shown in them, what it may; or else that which is produced by the intrinsic merit of the subjects themselves, though they may be merely imaginary ones. This year there is an unusual dearth of interest of either kind. There are besides a number of drawings, which though put into the architectural room hardly belong to it at all, more than the unlucky oil paintings which are stuck up there in order to be out of harm's way, till their owners send for them again. We allude to mere views and delineations of buildings, whose execution gives them no pretensions whatever as productions of the pencil, while the subjects they represent are either so exceedingly hackneyed, that their titles in the catalogue operate as a warning to pass them over; or so trivial, that we turn away from them as soon as beheld. Not a little provoking is it to find that few of those who do bring home any architectural sketches and studies from abroad, care ever to hunt out any thing fresher than such wonderful *rarities* as the Athenian Acropolis and Parthenon, and the Roman Coliseum and Forum. Does the actual capital of King Otho afford nothing whatever at all worth representing upon paper? Is his "Modern Athens" so deplorably insipid as not to have a single marked feature, or even any general physiognomy? It would seem that even our architectural draftsmen and sketchers are so infected with the "precedent-mania" that they dare not show us any building unless there is precedent for so doing by its having been represented times innumerable before. Whether it be abroad or at home that they go in quest of subjects, our architectural likeness-takers, seem terribly averse to novelty, or else they must fancy they have no right to take subjects from buildings which are so recent, that the office of showing them seems to belong exclusively to those who designed and erected them. The latter, however, do not always consider it worth their while to do so: certain at least it is that we do not find at the Royal Academy's exhibitions many of the things which are best of all suited for pictorial representation. The Colosseum in the Regent's Park, for instance, might have supplied more than one unusually striking subject, since, besides its beautiful Glyptotheca—perfectly unique as an interior—it offers many scenic architectural bits in other parts of the *place*, which would show still better in picture than they do in themselves, because in picture they would look like realities, whereas as seen in reality they are most undisguisedly only clever imitations and fictions. There might, again, have been one or two drawings of some of the apartments in the new building at Lincoln's Inn, and among them, both a general view and a partial one of the Library Yet, somehow or other,—and it may perhaps be as well not to inquire too nicely into the reason,—architects are apt to be of most stepmotherly disposition towards their own productions, begrudging what it would cost to let us behold them in pictorial effigy. Few of them take any generous interest in their art, as a fine art, and for its own sake; therefore they cannot with any sort of fairness complain of or express surprize at the indifference of the uninitiated, and the apathy of the general public;—and the latter seem to consider the architectural drawings little better than a dead weight on the Exhibition. Not a little mortifying is it to witness the hurried, listless glance bestowed on architectural subjects. If there be ever any thing of the kind among the oil paintings, it is never estimated except according to its execution as a picture. Even one of Scarlett Davis's glorious achievements of pictorial and architectural art,—one of Scandrett's fascinatingly exquisite groups of detail, or scenic views, has been known to engage attention far less than such horribly trivial subjects as swill-devouring pigs, turnip-munching boys, and strapping country wenches washing their not over and above delicate feet! How refined and poetic we English are in our ideas!

What sort of relish there is among the public for any thing relating to architecture is most disagreeably apparent from the circumstance of architecture being passed over altogether by the daily critics who profess to enlighten us in matters of art. The "big Times" has spoken of the present Exhibition without bestowing even so much as a syllable upon the architectural drawings. So that unless the "Times" be very much behind the times we actually live in, its silence as to our art is significant and expressive enough.—And what, all the while, is the Institute about?—has it done, is it doing, can it do, or does it care to do any thing, to give the requisite impulse, and bring architecture forward—and not only bring it forward, but force it upon the attention of the public? Leaving it to answer the question as best it can.

Of about two hundred and thirty subjects placed in the catalogue under the head "Architecture," barely one-half belongs to it, the rest consisting of graphic odds and ends—the very "tag-rag and bobtail" of the pictures; nevertheless the half constitute more subjects than can be properly seen, and the deficiency to be complained of is not so much that of quantity as of quality and interest. There certainly is very little of architectural interest in the solitary production contributed this season, after a couple of years' absence, by Professor Cockerell, for he makes his appearance rather as a truant from his own art, and ambitious of signalizing himself in another. This is all the more singular, because St. George's Hall, Liverpool, for the sculpture of whose pediment he here exhibits a design in No. 1254, (showing only the pediment and upper part of the columns, on a large scale), is the work of a different architect. Leaving more competent judges to determine the technical merits of the composition as one intended for sculpture, we can only say it strikes us as being so very Greek and classical as to forfeit character for originality; and at any rate there is nothing peculiar in the mode of its combination with the architecture, unless a *return* to the Greek system of placing entire statues within a pediment, can pass for an artistic conception; whereas by venturing to depart from ancient authority—as he has oft-times done in architecture—the Professor might have "initiated" a still more effective as well as perfectly new mode—produced by omitting the tympanum, and leaving the pediment quite open, except as filled in by the statues, (so fixed as to support the raking cornices); which would then tell all the more vigorously seen against the vacant space behind. Once adopted, this idea might be made to lead to other quite novel yet adequately matured effects, which we cannot now stop to point out, wherefore leaving this hint to suffice *ad interim*, we shall perhaps explain ourselves more fully at fitting opportunity. In taking leave of the Professor, we express the hope that we shall see him again next season somewhat more in *propriâ personâ*, and in his character of architect.

With the above exception—St. George's Hall—Grecian and Roman architecture does not appear to be in great request for any buildings of importance actually projected. The principal object of that kind which we here meet with is No. 1246, "Elevation of the new Theatre to be built on the east-side of Leicester-square," F. C. J. Parkinson; which, though it has been spoken of disparagingly by a contemporary, who calls it "an indifferent transcript of the Haymarket Theatre," appears to us a pleasing and tasteful composition, with some clever touches of original detail, and not only ornate but consistently so; and further, possessing more strongly marked and appropriate character than any of the existing theatres. If any resemblance can be traced between this façade and that of the Haymarket, it most assuredly does not amount to that of "transcript" or copy, much less to that of an "indifferent" one, since the "Haymarket," with its common-place straddling portico stuck up before a parcel of ordinary doors and windows, is in barbarously vile and vulgar taste. The drawing we are speaking of is not treated very happily as to colour, and we think it must be exceedingly incorrect in one respect, for according to the size of the figures, the columns must be forty feet or more in height, which is not very likely, the portico not being the centre height of the edifice. In all drawings of the kind, the only use of figures is to serve as a scale, therefore, unless they are strictly according to scale, they are neither more nor less than falsifications—sometimes even ludicrous ones, as, for instance, in the view of Sir R. Peel's new Picture Gallery, last year, where the figures in the room were only half the size of those representing the portraits on the walls; therefore, either the former were dwarfs, or the latter were colossal.

Critics differ; and it is, perhaps, but right that they should do so, since one opinion frequently helps to correct another, and where with dissent on some points there happens also to be conformity on some one other, the judgment passed in regard to the latter becomes tolerably well confirmed. Differ we do from the critic—one apparently very eager to get through his task with all possible dispatch—who, besides detecting in the preceding subject an unlucky resemblance to the Haymarket Theatre, regards with complacency such a production as No. 1174, "one of the designs submitted to the grand jury of the county of Clare for the Ennis Courts," as possessing claims on the score of originality of treatment. If not remarkably original, the treatment may be allowed to be unusual, yet hardly appropriate; neither the particular species of "Italian" adopted, nor the irregularity of the composition, befitting a public building in a town, especially one that ought to command attention by an expression of sober dignity, without playing at the picturesque. Let us hope that the design actually chosen is some degrees better than this "submitted" one. The two subjects just mentioned are almost the only designs this year for what can be called public buildings—that is, secular ones, and in other style than Gothic. We have, indeed, in No. 1214, what rather innocently calls itself a "Gothic design" for a town-hall and public assembly-room in the West of England, but as to its exact "whereabouts" we are left in most comfortable uncertainty, since it would be anything but comfort to be assured that there was any likelihood of so preposterous an affair being perpetrated anywhere. In this scarcity of designs for public buildings—except those which are evidently merely visionary ones—we may refer to No. 1217,—"The Lord Warden's hotel, &c., now erecting at Dover," (J. Beazley)—as a *quasi*-public structure, and what will certainly be a sufficiently conspicuous one—more so than it merits to be by the taste displayed in it. The main idea must, however, be a very favourite one with Mr. B., it being a repetition of what he showed us last year in what was then called a design for the Carlton Club House. What may be the differences between the two designs we are unable to say, but the principal portion is the same in both, and consists of a large Corinthian order above the ground floor, in coupled columns, with arches springing from their entablatures. (See our last Vol., p. 214.) It might have been thought that revision of the first design would have led to the adoption, for an arcade of the kind, to the more compact and legitimate combination of arches springing immediately from the capital of single columns.* The display affected by this columnar-arcade is, besides, far too pretensious for the building itself, which is so decidedly—don't print it "deucedly"—poor and unstudied in style, that the ostentatious decoration affected for it strikes as vulgar, tawdry, in *boutiquier* taste. When will architects learn to give more attention to what Cockerell calls "eurythym of quantities," and to consistency of expression, be it that of richness or plainness, or of any intermediate degree between the one and the other?

What could induce either Hopper or Railton to thrust forward into notice this year, their respective designs for the Nelson Monument, (No's. 1171 and 1313) we cannot imagine. Hardly can it have been any particular admiration which the former obtained at the time of the competition, that encouraged its author to bring it into notice again; yet, whether the drawing itself attracts notice or not, he has taken care that the subject shall not be overlooked in the catalogue, where it is spoken of more lengthily than intelligibly, it being impossible to make out how the little *tea-gardenesque* temple which constitutes the design, can possibly form part of a group of buildings for picture-galleries and exhibition-rooms. By singular coincidence, Railton's "Nelson Column"—too well known to require any remarks from us here—makes a gallant show in the catalogue, but is absolutely a nonentity in the Exhibition in comparison with his "Beau Manor Park," last season, of which mansion we should very thankfully have received an additional view this year. As to his "Riseholme Hall, adapted and enlarged for the Bishop of Lincoln" (No. 1194), it possesses no great architectural interest, though it certainly looks like a very enviable residence, and shows that bishops have no disrelish for the comforts and luxuries of this world. No. 1306, "The garden-front of Clifton Hall, Notts," (L. N. Cottingham), did not impress us at all favourably. In fact, while as to composition it is almost a nullity,—the house being a mere lumpish mass,—as to the style affected for it, it shows the worst extreme of the latest Elizabethan, when our *renaissance* had become prematurely exhausted and worn out, and had fallen into all the forced conceits and drivelling of *blasé* imagination. Whatever it has recommended itself by on this occasion, it can hardly be by its economy, since its crinkum-crankum ugliness must be of a rather expensive kind. Neither is it any advantage to this garden front that instead of being raised upon a terrace, it has a terrace rising up immediately *before* it. However, the painter has done all *he* could to command admiration by a bravely showy display of flowers and peacocks.—Infinitely more to our taste is No. 1326, "Lambourn Place, Berks, the seat of H. Hippesley, Esq., (T. L. Donaldson). If not very striking, this subject is a very agreeable and satisfactory one, both for its execution as a pictorial drawing, and for its unaffected yet sufficiently marked character as a design in the more sober style of the Elizabethan Tudor period. To say the truth, the style of house is rather that of a former period than of what any one might be likely to build at the present day, there being more of ancient gentility about it than of modern refinement.—As the immediately preceding No. is by the same architect, (almost the only member of the Institute who exhibits) we will speak of it here although it belongs to a different class of subjects. It is entitled the "Elevation of a design for an Insurance Office, being an attempt to adapt the cinque-cento style to the street architecture of the metropolis:" instead of "to adapt," the more suitable expression would have been "to introduce," because, as it seems to us, there is very little that indicates adaptation of the style to modern town-architecture in general, too much of what bears an antiquated and exotic look in it, being retained, for instance, in the form of the windows. There might have been more freedom, and less timidity and dryness of treatment; nor would it have been amiss had the drawing itself, which is now merely slightly shaded in India ink, been such as to ensure attention to the subject. Still it must be confessed that its utter want of pictorial attraction of any kind serves to distinguish it rather markedly from the subjects around it.

To return to mansions—Capernwray Hall, near Lancaster, shown in Nos. 1263 and 1340 (Sharpe and Paley), is one of the most ambitious, and shows careful attention to detail and individual parts, yet for a modern residence it looks but a gloomy sort of pile, with too much of the castle in its character. Of mansions or villas in the regular Palladian style there are none, but No. 1187, "Allenheads, now erecting on the property of T. J. Beaumont, Esq., in the county of Northumberland" (E. B. Lamb), is an application of what may be called the rural Italian villa style, that shows very great talent of a peculiar kind—the talent of accomplishing much with exceedingly limited means, for though the structure itself is simple even to plainness, it is rich in picturesque effect, and in well expressed character of an excellent kind, without artifices and affectations.—There are four designs for villas by Mocatta, small and rather showily coloured drawings, so unfavourably placed, however, that we did not give them much attention.—Of suburban villas and mansions similar to the "Kensington Garden" ones in last year's exhibition, there are none this season, although one since erected at Kensington would have furnished a subject. With respect to town and street architecture, designs for it are almost invariably confined to those for public buildings; we, however, get something so denominated in No. 1275 (W. H. Leeds), a design for a house-front, unusually ornate, though far from being violently showy, still it is what we must not hope to find the least favour with those ultra-orthodox and rigidly puritanical critics who turn up their noses at the Travellers' and Reform Clubhouses, and who look upon Barry as being scarcely a

* The church at Sacrow, shown in our present number, exemplifies such compound application of column and arch.

degree better than Borromini. By this remark it is not to be understood that the design we are speaking of is indebted to either of the two buildings just named for any of its features; on the contrary, it differs altogether from Barry's mode of composition, the middle window of the principal floor being not only distinguished from the others, but distinguished in a very eminent degree, for although the window opening is of the same size, its decoration forms a larger and loftier central compartment. There is some novelty also in introducing a bas-relief as a frieze between the principal floor and the one over it, where figures of the kind would be more distinctly seen than higher up.—We meet with subjects of street architecture for projected metropolitan improvements in Nos. 1175 and 1185 by W. J. Donthorn, and 1319 by Allom, the two former being designs for a new street in a direct line from Buckingham Palace to Westminster Abbey, and for a new Square adjoining the Abbey; and the other for improving the North bank of the Thames between London and Blackfriars Bridges. This last is a very able drawing, but the architecture is rendered quite subordinate, being treated as little more than background to the splendid and animated river view, which, as picture, would have been just as good had the present houses been represented. Perhaps it would be unfair to consider the buildings here put in as intended to do more than convey a general idea of the proposed line, for they are made up of just the same sort of showy fronts as are now in vogue for new trading streets. Were the separate elevations drawn out as usual and left to speak for themselves as designs, some of them, we fancy, would cut but a sorry figure. The same remark may serve for Mr. Donthorn's *projét*: as a street it would be a very great improvement, but as street architecture no great improvement if any, upon the samples we have got.

The transition from streets and the outsides of houses to the insides of the latter is so natural that "*Interiors*" seem to claim our attention next, almost as matter of course, but we must reserve our remarks upon them and the remaining drawings, for a second notice.

NEW METROPOLITAN CHURCHES.

St. John's, Charlotte-street, Fitzroy-square.—This church is now nearly completed. The style adopted in the more conspicuous parts of the building is Norman, or rather the modern mongrel between Norman and Romanesque. The west front exhibits two towers divided into stages; of these towers, that at the north-west angle is surmounted by a slate-covered spire. The rest of the façade consists of a gable, containing a triplet of round-headed windows, with a wheel-window above, and the west door below them. The surface of the west front is broken by small arches and columns of decoration, string courses, and a corbel-table. These members and the dressings are of Bath stone, the rest is faced with Kentish rag. As might be anticipated in a London church built in the line of a street and crammed in between the neighbouring houses, neither the interior nor the exterior of this edifice has the slightest pretensions to the *spirit* of Norman architecture, notwithstanding the imitation of some of the forms peculiar to that style. The cumbrous massive grandeur produced by the colossal proportions of the Norman era are here missed altogether. Instead of vast towers, walls of enormous thickness, and columns no more than three or four diameters in height, we have all the principal parts of a Norman cathedral comprised in the narrow space of a street elevation. The pigmy dimensions which the architect has consequently been compelled to adopt, give the idea that the building is meant rather as a sort of illustration or reduced model of a Norman church, than as a real attempt to build such an edifice in all the amplitude of its dimensions.

The church has neither transepts nor a central tower—almost universal features of ancient Norman churches. The dimensions of the interior are fully as diminutive as those of the exterior: the nave and aisles are divided by pillars and arches with wretched mouldings; the roofs are of open wood-work; the aisles are bisected by galleries, and the light is obtained from couplets of circular headed windows in the clerestory; consequently the north and south walls are blank, and the light is very unequally distributed.

The back of the church (we regret to have to apply the word "back" to a church, but the east end cannot in the present case be distinguished by a more honorable term,) is in a mews-yard, and it is needless to say that the architecture here exactly accords with that of the neighbouring stacles and coach-houses, being of the commonest brickwork. The designer seems to have been content with making a show, such as it is, in the main street.

French Protestant Church, Holborn.—The plan of this church, which has recently been consecrated, is a rectangle. The eastern end is in Bloomsbury-street, and the western in George street: the north and south sides are in the course of being blocked up by houses. The eastern elevation consists of a gable, without towers, and contains a large centre window with two lateral windows; underneath are doors, the entrance being—not at the western—but the eastern end (for the sake of facility of access, as the *Ecclesiologist* suggests, from "the more genteel street.") The great east window has five lights; but the floriation does not show much invention, being simply a number of trefoils contained within a pointed arch. The lateral windows in the same front are almost close to the central window, and in their proportions display a ludicrous contrast to it, being very narrow compared with their length, whereas the centre window is disproportionately broad. The group possesses neither the individual beauty nor the family likeness which would remind the observer of the three Graces.

The west front displays two long windows with a triangular window above, and beneath a string course, three lancets. This and the east sides of the church are faced with rag; the north and south are plain brickwork without any windows or mouldings. There has not been any absolute necessity for this nakedness, as on one side, a large open space of ground at present intervenes between the church and the neighbouring houses, and on the other side the architect himself has built a school abutting on the church. The interior of the church has of course the advantage of north and south walls perfectly blank.

At the end of the same street is another church which has recently been "done up." The style is one of which there are happily so few specimens that it has not yet received a name; we are therefore relieved from the necessity of a detailed criticism. We have only to notice, on account of their profanity, some extremely offensive ornaments with which the upper part of the exterior walls are decorated. On three sides of the building, which is bedizened in all the glories of plaster, in which it rivals most of the gin-palaces in the neighbourhood, are stucco ornaments bearing respectively the semblances of an equilateral triangle, a lamb bearing a flag, and a dove. It is needless to state what is typified by these figures, which are repeated several times in the order mentioned, so as to form a kind of frieze to three sides of the building. We trust that the incumbent clergyman will use his influence to get these profane and hideous symbols removed: as works of art they are on a *par* with the plaster images sold at fairs as toys for children.

Catholic Church, Farm-street, Berkeley-square.—This church is a very gratifying example of the rapid advances which have been made in the science of mediæval architecture during the last few years. While in Classic architecture the most barbarous perversions and absurdities—pediments surmounted by spires—columns supporting nothing—stilted bases—shafts broken by dies, &c.,—are still tolerated, our national architecture is cultivated with a purer and more philosophical taste, which is fast emancipating it from the hideous deformities of the last age. Mr. Scoles' design for the Catholic church near Berkeley-square is a satisfactory proof that our self-complacency is not without foundation.

The situation of the building is by no means advantageous; it is, indeed, almost impossible to get a good view of the exterior. From one corner of Grosvenor-square a glimpse may be obtained of the east gable, the beautiful Decorated tracery of the great east window, and the bell-turret; and another view from beside the ugly plastered church in Mount-street displays somewhat more of the new building. But still it is so hemmed in among the houses, that it can scarcely anywhere be viewed as a whole. The difficulties to be contended with in obtaining a suitable site may be judged of by the fact that the west entrance is in a mews-yard. The architecture of this part of the building will not however be made inferior to the rest because comparatively little seen: on the contrary, if there be one thing more to be admired than another in the design, it is that it displays perfect faithfulness and uniformity, and betrays no anxiety for what is colloqually termed "showing off"

The plan of the interior is nearly a rectangle (about 150 feet long) with aisles extending about half the length of the church from the east-end. These aisles are separated from the chancel and nave by piers and arches. There will be three altars—the high altar at the end of the chancel, and one at the east-end of each aisle. The side altars will be dedicated to the

Virgin and the Sacrament respectively. In the south aisle are three confessionals and the sacristy, and above the south arches in the chancel is the tribune. The light will be obtained from the east and west windows and from clerestories in the north and south walls. It is worthy of notice that the tracery of no two windows is alike, though the patterns of all of them are extremely rich: the design of the east window especially may be safely compared with some of the noblest examples of ancient Decorated architecture. With respect, however, to the absence of north and south windows below those of the clerestory, we have already given a general and distinct opinion. Our views on this subject have been so recently detailed that we need not now say more than that the examination of the church which we are describing suggested nothing which would modify our opinion. On the contrary, we can state positively that the effect of the light thrown down from above by no means harmonises with the character of the church, and that the large surfaces of blank unbroken walls are great defects. We say this the more freely because the excellence of the general design is sufficiently great to afford some drawbacks, and because the architect may justly plead the difficulties of the site as an excuse.

Parts of the interior walls will be plastered and painted with frescoes. This use of plaster is perfectly legitimate, for there is not the slightest pretension of making it look like masonry; it reveals itself honestly in its true character—that of a ground surface for the painting. No deceptive materials whatever are employed in the church. The external masonry is of Kentish rag; the mouldings, window-mullions, piers, &c., of Bath stone.

There is a temporary brick wall at the west-end: this is about to be removed for the purpose of completing the west gable, which will display three windows, with a door below the central window, and a trilateral window near the vertex of the gable. There will also be a bell-turret at this end of the church in addition to that now existing over the chancel arch. The roofs incline to the horizontal at an angle of about 60°; on the north and south sides of them are rich perforated parapets.

We hope to be able hereafter to give a more complete account of the church, and to accompany the description by illustrations.

NOTES ON ENGINEERING,
V.
MENAI TUBULAR BRIDGE.

Since the former paper (see *ante* p. 100), on the application of the theory of the strength of beams to the case of the Tubular bridge was published, a report has appeared of experiments by Messrs. Hodgkinson and Fairbairn, with reference to this particular subject. As far as analogy can be drawn between the method of those experiments and the investigation of which the present paper is a continuation, the results agree exactly. It will be observed however that the experiments had reference solely to the ultimate strength of the girders experimented upon—that is, to the extreme weight which they would bear before breaking, the present investigation however relates not so much to the *strength* of the girders as to the *strain* which they must have to bear; and as the results here arrived at are obtained from the fundamental laws of statics, and not from any assumptions respecting the nature of the bodies operated upon, the points of resemblance between this theoretical examination and the reported experiments are few. It has seemed sufficient in the present paper to point out the precise nature and amount of the forces which the metal will have to resist; leaving it to the engineer to contrive the proper means of fulfilling the requirements here pointed out.

We now proceed with the subject from the point where we left it in the former paper.

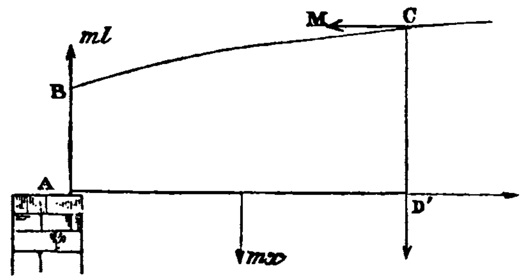
5. *Form of the Girder of uniform strength.*

When the girder is of uniform strength throughout, the strain on it is greatest at the centre for two reasons. First, from the weight of the girder itself independently of the load: for when a vertical section is made through the centre, it is seen that the molecular forces of the metal have to resist a greater moment of external forces, than when the section is supposed to be made elsewhere. Secondly, the load is a moveable one, and has the greatest moment when its centre of gravity is over the centre of the bridge. It is possible to vary the dimensions of the bridge so that the *strain on each square inch* shall be uniform throughout almost the whole length of the bridge. There are three ways of effecting this object—either by increasing the thickness of the plates towards the centre of the bridge, or by increasing the depth of the bridge towards the centre, or by combining both these methods. The second method is however the preferable one, because it does not require any considerable addition to the quantity of metal.

On narrow gauge railways the proportion of the loading of the goods trains to the length of the wagons is such that about 4 tons of load extend over about 9 feet of railway; consequently on the Menai girders (the length of which is 450 feet) we may take the extreme load to be 200 tons uniformly distributed over the length. We have now to find the law of the variation of the depth of the girder, so that its own weight, and the load together shall produce a uniform strain on the metal.

Let $2l$ be the length of the bridge, and m the weight of load and bridge together for a unit of length, and $2l\,m$ will be total weight supported. Consequently the pressure on each abutment will be $l m$.

Let a vertical section C′ D′ be supposed to be made at a distance x ($=$ A D′) from the end of the bridge. Then replacing the molecular actions by a vertical force along C′D′, and equal horizontal forces at C′ and D′; these new forces may be equated with the external forces, which are—first, the vertical pressure at the end A, which, as has been said, is equal to $m l$; secondly, the weight of the part A B C′ D′ ($= m x$), which may be supposed to act half way between A and D′. And as we



shall hereafter find that the curvature of B′ C′ is very small, it will be seen that the error arising form this supposition is quite inappreciable. Taking moments about D′ and calling the depth C′ D′, y, we have—

$$M y = m l x - m x \cdot \tfrac{1}{2} x.$$

Now y is supposed to vary so that M remains constant. Consequently, the equation to the curve B C′ will be

$$y = \frac{m}{M}\left(l x - \tfrac{1}{2} x^2\right) \text{ a parabola.}$$

It will be observed that by this equation $y = 0$ when $x = 0$ or $2l$, that is, the depth is zero at the two extremities of the beam. It is impossible, however, that this condition could be satisfied, since room must be left for the passage of the train. The height of common railway bridges usually allowed for this purpose is 15 feet, which gives a sufficiently clear space above the funnel of the engine; y, therefore, in the above equation, after it has attained the limit of 15 feet, must remain constant. The only effect of this will be that the bridge will be stronger than theory requires it to be, since, of course, if the depth towards the ends be greater than requisite, the result is an increased strength in those parts.

To determine the numerical value of m; the weight of a square foot of iron one inch thick is about 40 lb.: and since the Menai Bridge is to be 15 feet wide, the weight of one foot of the upper and lower plates together will be 1200 lb. The weight of the train we have supposed 4 tons to 9 feet, or about 1000 lb. to a foot. Consequently $m = 2200$; we will, for convenience of calculation put $m = 2240$ or 1 ton

M is to be found by determining its value at the centre of the bridge. Here $y = 30$ feet and $x = 225$ feet. Substituting these values in the equation to the curve, we find $M = 844$ tons; and since $l = 225$ and $m = 1$, the equation becomes—

$$y = \tfrac{1}{844}\left(225 - \tfrac{1}{2} x\right) x.$$

The following are some of the values of y, corresponding to given values of x:—

$x =$ 210 feet	$y =$ 29·8 feet
200	29·6
180	28·5
160	27·4
140	25·7
120	23·4
100	20·7
80	17·6.

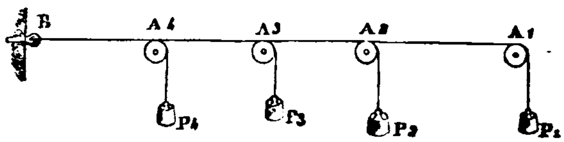
When x is between 70 and 60 feet, y will be reduced to 15 feet, and must not be farther lessened. By adopting then the form here indicated, the tension will be for 160 feet on each side of the centre uniformly equal to 841 tons, and for the 65 feet near either extremity will be less. Taking it however at 841 tons, we observe that, since the plates are 15 feet wide and 1 inch thick, and the cross section consequently contains 180 square inches, the strain per square inch on the metal plates is about $4\frac{2}{3}$ tons. Iron will bear a strain of 29 tons per square inch without breaking, and 9 tons without permanent injury; but the diminished strain here assigned to it is not too great an excess on the side of safety, when the diminution of strength at the places where the several pieces composing the upper and lower plates are welded or rivetted together is taken into consideration.

6. *Necessary strength of the vertical ribs.*

The beam of greatest strength for a given quantity of material is that in which the material is collected in two wide horizontal flanges, separated by a thin vertical rib. It has been usual to consider that no more strength is requisite in this rib than will suffice to keep the flanges apart; and the consideration seems to have been hitherto neglected in all philosophical investigations of the subject, that the longitudinal strains which the flanges exert upon the rib, render it necessary that the latter should have much more strength than what is required for the mere separation of the flanges. A very simple method may, however, be given for determining the exact amount of strength actually required in the rib by its connection with the other parts of the beam. As the subject appears to be an entirely new one, no apology is necessary for discussing it fully.

The most convenient method of determining the strains upon the vertical web or webs is to consider the vertical strains and the horizontal strains quite separately. This plan of keeping the two kind of forces perfectly distinct has been observed throughout these papers, and is by far the best for getting clear and precise notions of the subject.

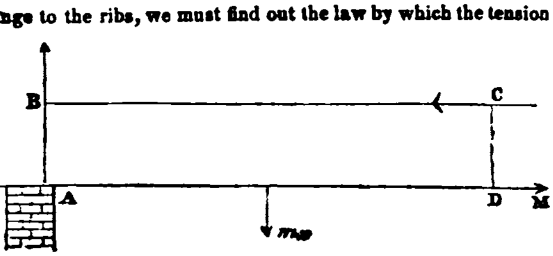
We will first consider the *longitudinal* strains which the flanges exert upon the rib. Now it is to be remembered that the upper flange is in a state of more or less compression throughout its length; and the lower flange in a state of more or less tension. We know, however, that a string stretched by two forces only, one at each end, is in a state of uniform tension throughout its length; but if forces be applied to the string at intermediate points along it, the tension will vary in various parts. For instance, suppose that a string, A_1 B, is fastened at B to a staple firmly fixed in a wall, and at A_1 passes over a pulley, and is stretched by a weight P_1, it is clear that if no weight but this act on the string, it will have a uniform



tension $= P_1$. Suppose, however, that at the points A_2, A_3, A_4, other weights are hooked on to the string and made to act upon it horizontally by means of pulleys, it is obvious that the tension of the string will now vary in various parts; between A_4 and B *all* the weights are acting on the string, and consequently the tension of this part $= P_1 + P_2 + P_3 + P_4$; between A_3 and A_4 the tension $= P_1 + P_2 + P_3$; between A_2 and A_3 the tension $= P_1 + P_2$; between A_2 and A_1 the tension $= P_1$.

Now, to apply this consideration to the lower flange of our girder—we observe that the tension of it varies in every part; this variation, therefore, arises from the action of horizontal forces at every point throughout its length, and it is certain that these horizontal forces have been communicated by no other means than by the vertical ribs.

In order to estimate the amount of the strains communicated by the bottom flange to the ribs, we must find out the law by which the tension of the



former varies. Let us first for simplicity suppose the depth of the girder uniform throughout and $= a$. Also let the whole length be uniformly loaded, and let one foot of the length of the girder with the load upon it $= m$; then if $2l$ be the length of the girder, $2ml$ will be its weight, and the reaction on the abutment A $= ml$. Also, if a section be made at any part CD and AD $= x$ the weight of the part ABCD $= mx$. Let the tension at D $=$ M. Then taking moments about C

$$Ma = mlx - mx.\tfrac{1}{2}x$$
$$= m(lx - \tfrac{1}{2}x^2).$$

Similary, if we had supposed a section made in the girder at a distance x' from the end, and that the corresponding tension was M', we should have the equation

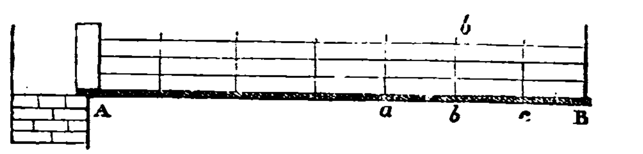
$$M'a = m\,(l\,x' - \tfrac{1}{2}\,x'^2).$$

Consequently

$$(M - M')\,a = m\,\left\{\,l\,(x - x') - \tfrac{1}{2}\,(x^2 - x'^2\right\}$$

This last equation gives the law of the variation of the tension.

We have now to see how this variation is produced by the vertical ribs. Let us first of all suppose that the connection between the upper and lower flanges is maintained—not by continuous plates—but by a *lattice* consisting of vertical and horizontal bars crossing each other. Now the upper horizontal bars will exert thrusts, and the lower, tensions. In the following figure, let A B represent a portion of the lower flange resting on the



abutment at A. Above A B are represented some of the horizontal bars of the lattice, but *those only which exert tension;* those which exert thrust as well as the upper flange being omitted in the figure. Now by this arrangement the tension of the portion of the bottom flange, between any two vertical bars is constant. For instance, the tension of that part of A B which lies between a and b is uniform, and of the part between b and c the tension is also uniform, only it is greater in amount than the tension between a and b. Call the tension between a and b, M_2 and between b and c, M_1, then it is clear that the vertical rod $b\,b'$ is solicited at the point b by two different horizontal forces, M_2, at the left of b tending to pull it *towards* the abutment, M_1 to the right of b tending to pull it further *from* the abutment. But M_1 is the greatest: therefore on the whole the rod $b\,b'$ is acted on by a force $M_1 - M_2$ tending to pull it towards the right. For the equilibrium of this rod therefore we must have equal forces tending to pull it towards the abutment. These forces are supplied by the tension of the *horizontal* bars above $a\ b$. Hence this conclusion—the aggregate tension of the horizontal bars above $a\,b = M_1 - M_2$.

Now if we suppose B the *middle* point of the beam, we know that the tension is equal and opposite on both sides of that point; that is, the tension of c B is equal to the tension to the right of B. Consequently the vertical bar at B will stand of itself without any tension of the horizontal bars above c B. The tension of these bars is therefore zero. The bars however above $b\,c$ are in a state of actual tension, the amount of which equals the difference between the tension of the portion B c of the flange and of the portion $b\,c$.

Let the successive differences of the successive portions of the flange be represented by $P_1, P_2, P_3 \ldots\ldots P_n$, then the bars above $b\,c$ are stretched by a force P_1 at c; the bars above $a\,b$ are stretched by a force P_1 at c and a force P_2 at b; the bars next to the left are stretched by a force P_1 at c, P_2 at b, and P_3 at a, and so on. Consequently the tensions of the horizontal bars are, to the left of the first upright rod, P_1; to the left of the second, $P_1 + P_2$; of the third, $P_1 + P_2 + P_3$ and so on. The tension to the left of the rth vertical rod $= P_1 + P_2 + P_3 + \ldots\ldots + P_r$.

But the forces $P_1, P_2 \ldots\ldots P_r$ are respectively equivalent to $M - M_1$, $M_1 - M_2 \ldots\ldots\ldots M_{n-1} - M_n$. Hence $P_1 + P_2 + P_3 + \ldots\ldots + P_n =$ $M - M_1 + M_1 - M_2 + \ldots\ldots + M_{r-1} - M_r = M - M_r$,

or the aggregate tension of the horizontal bars at any point is equal to the difference between the tension of the flange at that point and its tension at the centre.

But we have just shown that the tension of the flange at a distance x from the abatment

$$=\frac{m}{a}(l x - \tfrac{1}{2} x^2).$$

Putting in this equation $x=l$, we have for the tension of the flange at the centre

$$\frac{m}{a}(l^2 - \tfrac{1}{2} l^2) \text{ or } \tfrac{1}{2} l^2 \frac{m}{a}.$$

Hence finally we get the tension of the horizontal *rods* at a distance x from the end by subtracting the first expression from the second. This gives

$$\frac{m}{a}\left\{\tfrac{1}{2} l^2 - (l x - \tfrac{1}{2} x^2)\right\} \text{ or } \tfrac{1}{2}\frac{m}{a}(l-x)^2.$$

We will apply this very simple formula hereafter to show the necessary thickness of the vertical and horizontal bars, supposing the upper and lower flanges to be connected by a lattice work. For the present it is sufficient to point out that the same mode of investigation applies where the vertical ribs are not lattice work, but continuous plates. For though we have supposed the points of application of the forces which the flange exerts on the ribs to be separated by determinate intervals, it is clear from the foregoing reasoning that the result is the same whether those intervals be great or small. So that if the intervals be indefinitely diminished, that is if the rib and flange be joined at every point throughout their length, the expression for the strain which the one exerts on the other will be the same in both cases. H. C.

REVIEWS.

The Place of Egypt in the History of the World. By Chevalier de Bunsen, (Ægyptens Stelle in der Welt-Geshichte.) Hamburgh, 1845. 3 vols. 8vo. Plates.

The object of Dr. Bunsen is to *prolong* the *incipient* portion of man's history for about 2000 years, and to show, that where hitherto only an *unconnected* list of obscure names and dates was to be met, real history and chronology may be elucidated by our increased knowledge of ancient records, and the monuments of the land of the Nile. If the work before us were one relating to a country *un-monumental*, it hardly would fall within the scope of our Journal; but being one of Egyptian antiquity, we may give a brief account of its contents.

Looking over the numerous dates and names, and lists and tables of the three volumes before us, one hardly can imagine that one man's labour would suffice to construct such an array of chronological formulæ, as it were, from out of the *few* given data of such remote antiquity. But considering that we are now in 1846, and that Dr. Bunsen says that his research on Egypt began in 1812, the thing becomes plausible. Besides, there is no Egyptian scholar of the age with whom the author had not been intimately connected; and his work is a *resumé* of all what the great French expedition had begun, and such men as Belzoni, Salt, Champollion, Rosselini, Wilkinson, Col. Vyse, Perring, and last but not least, Lepsius, had brought to a pretty satisfactory close.

"To restore," says Dr. Bunsen, "the chronology of the oldest monumental nation of the world, from Menes to Alexander the Great, for an extent of at least 3000 years, would have been impossible without the perfect elucidation of those monuments and partly documents, which Manetho and Eratosthenes had before them. As geologists have endeavoured to find a *progress* in the formation of the strata of the globe, and therefrom deduce the epochs of our earth, we may accomplish a similar task, if, as is the case, the monuments of high antiquity of one of the most important worlds-nations be not wanting. To sift the chronology of these ancient times will be most feasible by the aid of *monuments*. Those monuments do not only date from much earlier times than the public in general (with exception of the *Egyptiologists*) are accustomed to expect; but they are of far greater import than even these have hitherto thought, because the chief monuments of the old reigns are the kings' sepulchres, and these sepulchres are the pyramids; and amongst them the world-famed *three* are, certainly, *not* the oldest. It is very remarkable, that we find on the field of the Pyramids (*Piramidenfelde*) almost all kings of the Memphis dynasty, but no name s-shield (*Namenschild*) which can appertain to the *thinite* kings. Those, however, may yet be discovered in the ruins of Abydos—that primæval metropolis of ancient Egypt which, notwithstanding the report of Strabo and the great import of the kings' table (*Königstafel*), has been entirely neglected by travellers. It is also remarkable that the building of Thebes is neither ascribed to the second *thinite* dynasty, nor to the first memphitic, which, as we said before, lays (according to all reports, traditions, and even historical traces) *beyond* the times historical. *A builder of Memphis*, however, *is* mentioned by Diodorus, according to a fragment of a popular tradition. According to this author, the eighth successor of Busiris II. built Memphis—then proceeds tradition: his daughter Memphis had conceived, from father Nile, a son Egyptos, a mild and just king, his successor. Busiris II. forms the concluding link of the ante-historical Thebaic traditions: he is the builder of Thebes. After him succeeded another dynasty, and the last king was the eighth of the successors of Busiris II., concluding therefore a dynasty of nine kings. His name was *Memphit*; he founded Memphis, and built a royal palace, not surpassed in after times—still, not approaching the older royal palace of Thebes." (p. 105, vol. 2.)

It was on this *very spot*—"that originated with Herodotus that part of his wonderful description of Egypt which treats of the Pyramid-epoch. Before him, the older Hecatæus had been in Egypt. What had become nearly clear by the discoveries of Belzoni, is now completely ascertained by the labours of Vyse and Perring, viz., that the regular entrances to the Pyramids were, (at the close of the original construction and the interment of the builder), shut from *inwards* by granite trap-doors, and slabs of rock; that, from that time, to their forcible opening, none had ever viewed their interior. A tablet sunk in the granite blocks of the dressing seems to have contained the hieroglyphic inscription, with the name of the buried and other particulars. The assertion of Niebuhr and Wilkinson, that the dressing was simply formed by the exterior slabs being subsequently (beginning from above) cut off at the angle of the slope, seems to be confirmed by Perring, and he adds that the surface was moreover carefully polished. The history of the destruction of these wonders of art shows, that curiosity and thirst after concealed treasures enticed the ancient caliphs, most probably, first, the son of Harun al Rashid, Mammun, to track an entrance; subsequently, especially under Saladin, the Pyramids, especially their dressing, were regularly used as quarries; in fine, the recklessness and destructiveness of the Mamelukes completed the sacrilege." (p. 149, vol. 2.)

The historical details of the building of the thirty Pyramids of Egypt, put forth by M. Bunsen, are numberless, but cannot be brought within the compass of this Journal. The biographical notice of the builders of the *two largest* pyramids will, however, interest our readers. "With the extinction of the two *Menes* lines, the southern and northern, after the death of Amchura-Bicheris the ninth king of the first Memphis dynasty,—another family, probably a memphitic one, related to the former, ascended the throne of Egypt. The first two rulers were the brother-kings *Chufu*. The elder built the second greatest Pyramid, and made a commencement of the stupendous stone wall; the largest also was probably begun during his reign. The younger brother, erected (according to Manetho) the *largest*, as a sepulchre for himself, wishing to surpass his brother by its size, as well as by the splendour and solidity of construction. He, however, disdained the dressing of the lower part with the reddish granite of Syene, which distinguishes the second largest Pyramid."

A great part of the second volume of our author is taken up with a historical disquisition on the Mœris Lake—the most stupendous, hydraulic work which has been constructed in any age. Situated at the confines of the Lybian Desert, it escaped the notice of travellers, until M. Linant, chief engineer of roads and bridges to the Pacha of Egypt, made a considerable step towards exploring it.* "Egyptian irrigation," says Dr. Bunsen, "requires two things—canals and dykes. The system of the former, in the district alluded to, may be traced out so far, that the main canal had to serve the purpose of *retaining* the water on the *upper* slope of the land, and then to distribute it to the right and left, as well as westward to the *second* slope. The canal leading on the right side to the lake, caused an immediate connection of the Bahr Jusef with the Lake, and would at least serve for the irrigation of those lands it passed through, if the waters were dammed up in it. The second system is that of dykes, for the purpose of retaining the flood-water at the height to which it had been previously raised, until the Nile slime has been deposited and fertilized the land. The irrigation of the lower parts is effected by the piercing of the dykes; and a similar system (instead of artificial sluices) we may imagine to have been resorted to during the period of Egyptian antiquity. But there were also artificial dyke gates for the same purpose." (p. 217, vol. 2.)

* "Memoir on the Lake Mœris; read before the Egyptian Society, July 5, 1842." Memoire sur le lac, etc. Alexandria, 1843; 4to., with a coarsely engraved map on stone.

What the ancients thought of this artificial *sea* may be gathered from Strabo, who says, "This nomos (*Fajum*) is the most remarkable of all, as well for its natural fertility and beauty as for the art exhibited in its construction. It comprises also the so-called Mœris Lake, almost as large as an inland sea, and of the sea-colour; its banks, also, have the appearance of sea shores. It is capable by its size and depth, of containing, at the time of the flooding of the Nile, its abundant waters, without overflowing the inhabited and fertile land; at the receding of the river, the superabundant waters return by the same channel, by one of the two embouchures; while so much as is required for irrigation, both in the lake and channel still remains." Herodotus states its circumference to be upwards of 3000 stadia, equivalent therefore to the whole extent of the Egyptian coast on the Mediterranean, an assertion which Chevalier Bunsen considers to be correct.

In this interesting locality, the tombs of Mœris and his wife, in the Fajum, north of Crocodilopolis, are yet to be adverted to. At present, only two pyramidal structures are to be seen; but the German traveller, Wansleb, had seen (1664), on these very pedestals, the fragment of a colossal statue of a king, in a sitting position. Wilkinson recognized, in these two ruins, the Pyramids seen by Herodotus; and Perring, though ignorant of the researches of Wansleb, had guessed, with great tact, the whole arrangement. He assumes the ruin to be the foundation of a truncated Pyramid. According to Pococke, the ruin with the destroyed king's statue was called by the natives *Har'm*, the Pyramid; according to Jomard, *rigl Faraun*, the feet of Pharaoh. Mr. Perring, on the other hand, told Dr. Bunsen orally, that other people still called the two pediments *Senem*, the statues; or in Arabic, *Musthamel*, the "bathed ones;" whence the former architect supposes that the pedestals, and even the lower parts of the statues, were once bathed by the floods of that fertilizing irrigation, which the great king had secured for his land and people. Our author concludes his notice of this stupendous artificial lake in the following terms;

"Thus Mœris's statue surveyed the land which, from bog and desert, he had changed into blooming fields, and converted (for thousands of years to come) into the garden of Egypt. A work lay before and around him, the equal of which for magnitude and utility the world does not know. Wall and dyke remain even now, like a work of nature, after ages of neglect; even nature seems to have been surpassed, for the Nile found, through the Lake Mœris, an efflux from his stream-bed and no longer flowed into the sea—thus supply and utilization were both calculated. This structure, nearly five thousand years' old, would alone prove the art, skill, and science of the old Pharaoh dynasty to remotest posterity, if there were no annals to testify of it."

"Such, therefore, was King Mœris's work and sepulchre. When the floods of the Nile, augmented by those of the lake, covered the land, his and his queen's statues appeared above the waters, and seemed to the beholders like the tutelary deities of the spot."

RAILWAYS. *Their Use, Progress, and Construction.* By ROBERT RITCHIE, Associate of the Institution of Civil Engineers. Longman, 1846. 16mo. pp. 444. Woodcuts.

The object of this book is to give a general historical account of the improvements which have gradually taken place in the construction of railways, and the application of the motive power *upon* them from the time of their first introduction. The work is divided into three principal parts—the construction of the railway—the motive power—and the causes of railway accidents. Under the first of these heads the writer shows how the first idea of wheel tracks of stone and iron tramways, became gradually matured and improved, till it led to the construction of railways as the universal means of land transit. This account is followed by some general views of the rigidity of iron rails, their forms and weight on different railways, and the different modes of fixing them by transverse sleepers, longitudinal sleepers, and stone blocks set at intervals; with a comparison of the merits of each system. The author generally states the arguments on each side of a controverted opinion with remarkable fairness, but in the present instance, though he has given very fully the arguments in favour of longitudinal bearers, he has not devoted quite enough space to the consideration which the advocates of transverse sleepers urge in reply.

The various shapes of the wheel flanges, the methods of passing crossings by means of points or switches, the construction of turn-tables, &c., are next detailed. Under the heads of retaining walls and viaducts, accounts are given of the size and construction of some of the principal of these works hitherto executed.

Under the head of motive power of railways, we have the history of the different improvements of locomotive engines, from the time of the experiments on the opening of the Liverpool and Manchester Railway. In considering the advantages and disadvantages of the atmospheric railways, the author is careful to state facts only and the opinions of others, without coming to any determinate opinion as to either the locomotive or atmospheric system, except that in which every impartial and competent person will concur, namely, that "it must be left to time to test their comparative advantages, for at the present time the accounts of the latter are conflicting and contradictory."

To give a better idea of the book than can be obtained from mere description, we have selected the following extract, making however a few omissions. The subject is the various forms and dimensions of iron rails:—

"Mr. Barlow came to the conclusion, that the strength of a bar should be double that of the mean strain or load. In his first report, he thought from 10 to 20 per cent. would be sufficient; that is, for a 12-ton engine, as the weight is at present distributed, a strength of 7 tons would be ample provision; and with greater accuracy of construction, a less strength would suffice; or rather, allowing the same strength, an engine of 14 or 16 tons might be passed over with greater confidence. Thus, for 12 tons' weight, with a velocity of about 35 miles per hour, 7 tons would allow a surplus strength of 16 per cent. beyond double the mean strain. The deductions from his experiments led him to recommend that the section of an iron rail for a 5-feet bearing, with strength 7 tons, should not exceed 5 inches in depth; that the head ought not to be less than 2·25 lb. per yard, and be 1 inch in depth; that the whole weight at the sections should be 67·4 lb. per yard; the thickness of the middle rib, ·85 inch; depth of bottom web, 1·66 inch; and breadth of ditto, 1½ inch; that the deflection of such a rail, with 3 tons, would be ·064 inch.

"For bearings of less width, he did not reduce the weight or size of the head, but kept it at the same section, decreasing the whole weight and depth of the rail: thus for a strength 7 tons, with a 3-feet bearing, the whole weight was 51·4 lb., whole depth 4½ inches, depth of bottom web 1 inch, breadth 1·25 inch, thickness of middle rib ·6 inch, deflection with 3 tons was ·024 inch.

"Notwithstanding that Professor Barlow expressed a strong opinion in favour of the single-flanched rail over the double,—that he could see no advantage the latter possessed to compensate for its actual and obvious defects, that he considered it inferior in strength and convenience in fixing, and that the advantage it was supposed to possess, namely, that it might be turned when the upper table was worn down, was impracticable, and that he saw no advantage in the broad bearing,—still the double-headed rail, in practice, has almost entirely superseded the single one: whether the adoption of the double one arises from affording greater convenience to the rail layer, and facilities for keying it, and the advantage of having the power of reversing it, and selecting the best side, or from the manifest advantage of a broad bearing to the rail,—this form is now generally preferred.

"The Liverpool and Manchester Railway Company has of recent years adopted a double parallel rail of a peculiar section; not admitting, however, of the power of turning it. The object to be attained in adopting this shape, is stated to be, that by having the part of the rail upon which the flanch of the wheel acts, of the same outline as the flanch itself, greater strength is given to the rail, while the other edge of the rail is lightened. These rails have been laid down at 60 and 75 lb. per yard.

"The more common and useful form of a double parallel rail, is when the segmental outline is the same at top and bottom: for although it cannot be denied that the weight of the bottom flanch does not add proportionably to the strength of the rail, nor even that the power of turning it is at all times practicable,—yet there cannot be any doubt that this form, for railways constructed on separate blocks and sleepers, presents many advantages; and besides, as the cost is nearly the same for a rail with the top and bottom flanches alike, with that where the bottom web is somewhat lighter, no hesitation can exist in preferring the former, however much theoretical deductions may mystify the subject.

"A double parallel rail, weighing 75 lb. per yard, has been laid down on the London and Birmingham, Eastern Counties, South Eastern, Edinburgh and Glasgow, and many other railways. The whole depth is 5 inches, the top and base are the same sections, 2·5 inches, the thickness of middle rib is about ¾ of an inch, or less.

"A double parallel rail has been used upon the Grand Junction and other railways, weighing 62 lb. per yard; whole depth, 4·5 inches.

"A double parallel rail, about 65 lb. per yard, of which the whole depth is about 4¾ inches, has been laid down on some parts of the London and Birmingham railway.

"A 75 lb. rail was laid down on the Edinburgh and Glasgow railway. The inner side of the chair being curved, admits of ample space for the key to wedge the rail firmly.

"The rail and chair which are now laying down on the North British railway are about 70 lb. per yard, in 12 and 16 feet lengths. The top and base are different sections, probably adopted with a view of saving in the weight, but presenting no corresponding advantages. The keys or wedges are made of oak, and are small in size.

"It seems generally agreed, that the bearing surface for the wheels to run upon, without being too heavy, or so narrow as in an additional degree to wear the wheels, should be about 2¼ inches; and hence this size of a head is generally adopted for public railways. Although, both theoretically and practically, it has been assumed, by Messrs. N. Wood, Barlow, and E. Wood, that the strongest form of rail is that of which, with sufficient depth for rigidity, the base does not contain too great a quantity of material,—and though Mr. Barlow has given a formula for calculating the section of greatest strength,—still the great object that the public are interested in, is the best form of rail for safety; and of which, while it has sufficient strength to bear upon it heavy loads in motion, the bearers should not be too far apart, to increase in the least degree the amount of either vertical or lateral deflection. When a rail possesses these advantages, its exact shape on mathematical principles is of less importance than its convenience of being easily fixed, and quickly shifted. Hence, while the single parallel rail is decreasing in practical application, the double one, from its convenience, is progressively extending. A knowledge of these facts is essentially necessary for every one engaged or connected with railways, whether he be a director or shareholder, whether an engineer or manager. With all the knowledge yet acquired, there is ample evidence of the uncertainty which still hangs around the subject; and the great expense it has already cost some of the older companies in making alterations, shows that experience to them has been dearly bought. For example, it has been shown that the Liverpool and Manchester Railway Company has had several times to alter the rails on that line; to increase the weight from 35 lb., the weight of the original rail, to 50 lb., 65 lb., and 75 lb. per yard, successively; while the London and Birmingham Railway Company, notwithstanding the advantages derived from Mr. Barlow's able report, was obliged to reduce the width of the bearings or supports from 5 feet to 3 feet 9 inches, and to increase the weight of the rails from 64 lb. to 75 lb. On other railways equally expensive alterations have been made. There is every probability, therefore, that, so long as that plan of railway construction continues, whatever may be the first cost to railway companies, a still greater weight must be given to the rails, and a still farther reduction of the width of the bearers must take place, in order to adapt the stability to increased rapidity of traction.

"It may be observed that the rails have gradually been increased in strength since steam power was introduced; the bars are usually made in 12, 15, and 16 feet lengths, with square or butt ends, and are laid end to end, the earlier complex contrivances to secure the joints being all dispensed with, and the half-lap joints now rarely used. About $\frac{1}{16}$ of an inch, at least, should be left between the ends for expansion; for it has been ascertained that a bar of 15 feet in length will expand about $\frac{1}{11}$ of an inch at 75° F. Some have, indeed, proposed to place a small piece of wood between the ends of rails, as the different expanding properties of wood and iron would fill the space, the wood expanding as the iron contracts: but such a plan is liable to objection from the wood being likely to be shaken out, and the space being left vacant. There is no part of railway construction that requires more accuracy of fitting than the joints: the squareness of the ends, and the space allowed for expansion, cannot be too carefully regulated. Instead of that, how often are seen spaces at the joints of different widths, and the ends of the bars in juxtaposition, without parallelism and uniformity of level; thus increasing the amount of friction, adding to the jolting and rocking motion, and to the risk of the wheels of carriages being thrown off the rails."

This little work contains a large quantity of information in a very small compass. The information is not perhaps quite profound or minute enough to be of great value to the experienced engineer, but the student who is commencing the subject will find here a general and compendious view of it, which will form a useful and certainly a very interesting introduction to more recondite researches.

Railway Map of England and Wales.—Messrs. Arrowsmith and Basire have recently published the large railway map of England and Wales engraved by them for the Board of Trade from plans deposited there in November last. Having only printed a few copies for the Committees of the Houses of Lords and Commons, the publishers purchased the plates from the Government, considering them interesting to the public, as giving an authentic account of all railways up to the commencement of the present time, showing those in *operation*—in *progress*—*projected*—those that failed at the Private Bill Office the end of December—and those for which petitions were not presented to the House afterwards.

A similar map of Scotland, and one of Ireland, are soon to appear. Of the map before us we can give no better encomium than by saying, that its magnificent size and the style of execution render it fully worthy of the reputation of the publishers, and of the occasion for which it was originally engraved. The size is 4 feet 9 inches by 6 feet.

OBSERVATIONS ON CAPILLARITY.

By Prof. Henry.

In 1839, the author presented the results of some experiments on the permeability of lead to mercury; and subsequent observations had led him to believe that the same property was possessed by other metals in reference to each other. His first attempt to verify this conjecture was made with the assistance of Dr. Patterson, at the United States Mint. For this purpose, a small globule of gold was placed on a plate of sheet iron, and submitted to the heat of an assaying furnace; but the experiment was unsuccessful; for, although the gold was heated much above its melting-point, it exhibited no signs of sinking into the pores of the iron. The idea afterwards suggested itself, that a different result would have been obtained had the two metals been made to adhere previous to heating, so that no oxide could have been formed between the surfaces. In accordance with this view, Prof. Henry inquired of Mr. Cornelius, of Philadelphia, if, in the course of experience in working silver-plated copper, in his extensive manufactory of lamps, he had ever observed the silver to disappear from the copper when the metal was heated. The answer was, that the silver always disappears when the plate is heated above a certain temperature, leaving a surface of copper exposed; and that it was generally believed by the workmen, that the silver evaporates at this temperature.

Professor Henry suggested that the silver, instead of evaporating, merely sunk into the pores of the copper, and that by carefully removing the surface of the latter by the action of an acid, the silver would reappear. To verify this by experiment, Mr. Cornelius heated one end of a piece of thick plated copper to nearly the melting-point of the metal; the silver at this end disappeared, and when the metal was cleaned by a solution of dilute sulphuric acid, the end which had been heated presented a uniform surface of copper, whilst the other end exhibited its proper coating of silver. The unsilvered end of the plate was next placed, for a few minutes, in a solution of muriate of zinc, by which the exterior surface of copper was removed, and the surface of silver was again exposed. This method of recovering the silver before the process of plating silver by galvanism came into use, would have been of much value to manufacturers of plated ware, since it often happened that articles were spoiled, in the process of soldering, by heating them to the degree at which silver disappears.

It is well known to the jeweller, that articles of copper, plated with gold, lose their brilliancy after a time, and that this can be restored by boiling them in ammonia; this effect is probably produced by the ammonia acting on the copper, and dissolving off its surface, so as to expose the gold, which, by diffusion has entered into the copper.

A slow diffusion of one metal through another probably takes place in cases of alloys. Silver coins, after having lain long in the earth, have been found covered with a salt of copper. This may be explained by supposing that the alloy of copper, at the surface of the coin, enters into combination with the carbonic acid of the soil, and being thus removed, its place is supplied by a diffusion from within; and in this way it is not improbable that a considerable portion of the alloy may be exhausted in the process of time, and the purity of the coin be considerably increased.

Perhaps, also, the phenomenon of what is called *segregation*, or the formation of nodules of flint in masses of carbonated lime, and of indurated marl in beds of clay, may be explained on the same principle. In breaking up these masses, it is almost always observed, that a piece of shell or some extraneous matter occupies the middle, and probably formed the nucleus, around which the matter was accumulated by attraction. The difficulty consists in explaining how the attraction of cohesion, which becomes insensible at sensible distances, should produce this effect. To explain this, let us suppose two substances uniformly diffused through each other by a slight mutual attraction, as in the case of a lump of sugar dissolved in a large quantity of water, every particle of the water will attract to itself its proportion of the sugar, and the whole will be in a state of equilibrium. If the diffusion at its commencement had been assisted by heat, and this cause of the separation of the homogeneous particles no longer existed, the diffusion might be one of unstable equilibrium; and the slightest extraneous force, such as the attraction of a minute piece of shell, might serve to disturb the quiescence, and draw to itself the diffused particles which were immediately contiguous to it. This would leave a vacuum of the atoms around the attracting mass: for example, as in the case of the sugar, there would be a portion of the water around the nucleus deprived of the sugar; this portion of the water would attract its portion of sugar from the layer without, and into this layer the sugar from the layer next without would be diffused, and so on until, through all the water, the remaining sugar would be uniformly diffused. The process would continue to be repeated, by the nucleus again attracting a portion of the sugar from the water immediately around it, and so on until a considerable accumulation would be formed around the foreign substance.

We can in this way conceive of the manner by which the molecular action, which is insensible at perceptible distances, may produce results which would appear to be the effect of attraction acting at a distance.—*From the Proc. of the American Philosophical Society.*

KENTISH RAGSTONE.

To Mr. Whichcord we are indebted for the following practical information regarding Kentish Ragstone, used by our forefathers rather largely in many of our Gothic edifices, and at the present period it is again introduced with considerable advantage; it affords, combined with dressings of Caen stone or Bath stone, an economical and, at the same time, a durable material for the construction of the walling of our ecclesiastical edifices, for which purpose it bids fair to supersede facings of white, red, and yellow bricks, and when it is judiciously introduced is very little, if any, more expensive. There is not a question as to its superior advantages in an architectural point of view.

Mr. Whichcord is an architect of extensive practice in Kent, and has had an opportunity of watching the working of Kentish ragstone, both in the quarry and in the building; he is, therefore, fully qualified to give us an opinion of its merits, which he has done in a pamphlet just published,* containing the whole of his paper, read at the Institute of British Architects, noticed in the Journal for January last, page 27, where we gave an account of the geological character of the stone, and which we now propose to follow up by adding some information regarding its practical uses.

"The larger blocks of Kentish Rag Stone of superior quality, are locally known under the name of ashlar, which comprises all work that is bedded or jointed; in fine, the stone when applied to any of the uses for which Portland or York are generally available. Stone of this description is sold by the cubic foot, and fetches a much higher price in proportion than the smaller kind.

The stone, when quarried, first has its rough projections knocked away, and for economy in transport (as the blocks cannot be sawn) is usually reduced as nearly as possible to its required dimensions. This process is technically called "skiffling," (termed "knobbling" in the neighbourhood of London, and also in the west of England,) and is performed with a heavy, double pointed hammer, such as is used in working granite. The necessity for this practice would cause great waste upon the stone, if the fragments of the better description were not available for burning into lime. The best lime, however, is usually burnt from the best stone.

Ragstone ashlar is usually dressed with the hammer, either roughly or with more care, in which state it is said to be "*roughly picked*" or "*close picked.*" In the better kinds of work it is usual to run a tooled draft round the arris of the stone, which gives to the blocks a very neat appearance; sometimes the whole face is tooled, a process which greatly increases the labour without adding to the beauty of the stone; even the best kinds are full of small hassocky spots, which show themselves upon a smooth face, turn rusty upon exposure to weather, and facilitate the decay of the stone. A building faced with tooled ashlar, even when newly erected, exhibits the appearance of bad Portland when going rapidly to decay: an evil that is not lessened by the frequency of the joints, necessarily caused by the small size of the stones, and a defect which is not so observable when the face of the work is picked. Sunk work and moulding upon ragstone should, as much as possible, be avoided, both from the great cost of executing them in so hard a material, and the rapid decay that so much wrought surface causes in this stone. The mediæval builders were well aware of this fact, and while they used ragstone extensively in the more substantial parts of their structures, preferred Caen or even fire or sandstone for the decorated portions. Caen stone is more peculiarly appropriate to be used with ragstone, on account of the small difference of the two materials in colour, a distinction entirely obliterated by time.

In using "*ragstone ashlar*" great care should be taken to have the stone laid upon its natural bed, as any other proceeding will almost certainly be followed by rapid decay; not but that I believe the stone in its soundest form to be almost beyond the influence of time or the elements, but that from the thinness of the strata, blocks of a large size can seldom be entirely freed from hassock; and even what appears to the eye as blue stone, does, for a considerable distance inward, retain the perishable nature of its enveloping crust. A block of ragstone (if the face be worked) will present, in damp weather, an appearance precisely similar to the heart and sap of timber.

When it is necessary (as in case of copings, &c.) that one bed should be exposed, care should be taken in skiffling the stone to reduce its dimensions as much as possible from the upper side, so as to expose only the soundest portion of the stone to the action of the atmosphere. In some situations, such as mullions, and door and window jambs, an unsightly appearance would be produced by too exact an attention to the beds of the stone, as the ashlar is generally too small to range with more than one course of headers. In these cases the old masons seem to have departed from their usual rule, and to have set the blocks on end so as to embrace two or three courses; but as the depth of the block required to work an ordinary jamb or mullion is not very great, it is not a difficult thing to get the whole thickness required out of the heart of stone, and where this has been done, the work will be found pretty free from decay.

Stone of the smaller layings is generally worked into headers, and used for the facing of walls, or for paving. In dressing headers for building purposes, it is common to work one side of the stone to a rough face with parallel sides, without paying much attention to the beds and joints, which often recede at an acute angle with the face, so as to bring the stones, when laid, to a closer joint. Attention, however, should be paid in building to have the stones properly pinned in behind, and carefully bonded with the work at back. Headers are generally knocked out to six, seven, eight or nine inch gauge for the height; the length and tail being determined by the size of the stone. Most headers, however, on face do not vary a great deal from the square form. No attention is paid to setting headers on their natural bed, as the appearance of the work is not so much injured by any superficial decay. It is not unusual, however, to find stones in an old wall entirely gone from this cause.

"*Coursed header work.*"—There are several modes of building with ragstone, either now in use or practised by our ancestors. That most frequently adopted in the better kind of modern buildings is the *coursed header work*, in which headers of an equal height and parallel joints are laid round in a similar manner to brickwork. There is always something stiff and formal about this kind of work, from the large size of the joints marking out each stone in distinct individuality. To make the matter worse, the work is generally finished with a raised or a sunk joint, and the mortar coloured of a deep blue colour; sometimes we see the work *even* tuck-pointed, as though it were designed to set each stone in a frame. *Coursed header work* is particularly inapplicable to the free forms of pointed architecture. If used at all, the stones should be laid in ragstone lime mortar, not *chalk lime*, and the joints simply struck. As far as appearance goes, it would be almost better that they were left rough. Chalk lime should be especially eschewed as both æsthetically and practically bad. It will not adhere to the ragstone, and the difference of colour is more offensive than when *blue* mortar is used.

"*Random coursed work*" seems to have been an improved mode of building, viz., the carrying up all the walls as nearly as possible together; this led to the practice of levelling out the work in a rough manner at every foot, or sixteen inches in height, carrying up each portion with stones of various sizes, roughly headed (as facing them is termed), and without much attention to jointing. It consequently occurred that one stone would sometimes occupy the height of two or three, while the rough sides caused continual irregularities in the joints. Great care is, however, frequently shown in fitting smaller stones to the irregularities of the larger ones, and the result of the whole is a more substantial mode of building, and greater uniformity of surface; the joints, from not occuring in straight lines, being much less observable than in header work. The bond, too, is much more complete, and an inspection of our county churches, of which most have the towers executed in this style, will convince any one of its durability.

"*Random header work.*"—There is, however, now in use a kind of approximation to "random-coursed work," that is even more objectionable than header, or rubble work; I mean "random header work." This, though only applied in inferior situations, is nearly as expensive as coursed header work, which *it is* in fact, only done in a more slovenly manner. It is executed with headers of the ordinary description, but of unequal sizes, as though attempted to be carried up in courses. The joints of the mortar are generally left *rough*; this lessens the bad effect that would otherwise be produced by the *arrangement*, or rather *no arrangement*, of the headers; but when the whole is done, the courses are only crooked, when, to all appearance, they were intended to be straight.

"*Random work*" is a style now much used in ornamental buildings, such as lodges, cottages, almshouses, dairies, &c. &c. It is commonly executed with unsquared stone, with the joints carefully fitted together and pinned in with smaller stones. When this description of work is well done, the joints never run in continuous, horizontal, or vertical lines, and every stone ought to break joint. The appearance is very good, but considerable time and much skill and nicety are required for its performance. Of course, from the mode of building in this style, it is scarcely applicable to large works, both because there is a certain littleness of appearance about it, and that it is wanting in the requisite stability.

"*Rough random work*" may be placed in the same class as that just described, but executed in an inferior manner. In this description of work it is not customary to give the stones any dressing at all, but merely lay them together with as much compactness as their irregular forms will allow; filling in between the larger stones with smaller pieces. When this kind of work is well done, it will be found very durable, and it is not an uncommon practice, where ragstone abounds, to build inclosure walls in this manner, but without using mortar or any cementing substance; and walls thus constructed will last for a considerable length of time. It is the cheapest kind of building, as there is less waste in the stone, and the expense of heading is saved, besides that a good workman will do more of it than of header work in the same time. Foundations are usually laid in rough random work, and it is applied to inclosure walls and inferior buildings.

Galleting.—It is customary in many parts of the county to "*gallet*" the joints of ragstone work; that is, to stick small "stone pinners" as thickly as possible in the pointing mortar. Galleting* is applied indifferently to every description of work, and it has the good effect of securing the joints in a great degree from the action of frost, (?) and in some situations it improves the appearance of the work.

Mention has already been made of the use of hassock as an inside lining to walls built with ragstone It is usually roughly squared, an operation that should never be neglected, as the crumbling nature of the stone

* A Pamphlet, "Observations on Kentish Ragstone as a Building Material." By John Whichcord, jun., architect. London: John Weale.

* The masons call the pieces of stone chipped off by the stroke of the chisel "galets," probably from "galette" (French) a small cake.

would endanger the security, if the work is exposed to the unequal pressure that would result from the use of irregularly shaped stones. Care should be taken not to place hassock in situations where it is exposed to very great pressure. For jambs, arches, &c., sound bricks are best to be used with it. When the work is of a superior description, and the masonry intended to show inside, as is sometimes the case, the hassock is capable of being worked to a very good surface with close joints; and as it can be procured in blocks of a considerable size, hassock is very applicable as an internal facing.

Ragstone Paving.—In Kent, ragstone is much used for paving. In most of the towns of this district the streets are laid with ragstone headers, in the same manner as granite is used in London; stables and yards also are paved with headers, which are generally preferred for these purposes to any other paving material. It is better, however, in public thoroughfares where exposed to heavy draughts, to make the kirb stones of granite.

The durability of buildings erected with ragstone depends mainly upon the qualities of the *lime* from which the mortar is made; it can only be depended upon when executed with mortar made with lime burnt from the ragstone itself; this mortar becomes in the lapse of time so very hard as to form almost one and the same body with the stone. Many buildings may be seen that have been erected a number of years that retain the original pointing in the joints, fair as when first finished, and so hard as to resist the blow of a chisel.

Ragstone lime is usually burnt in inverted conical kilns from seven to ten feet diameter at the top, such as are ordinarily used in this neighbourhood in common for burning either chalk, or ragstone lime. The process is the same in either case, but the ragstone requires more fuel for its conversion into lime. A kiln of the ordinary size will burn from one and a half to two loads per day, each load averaging 36 bushels. A load of lime requires for its production about four chords of stone, and one third of a ton of coals.

Although ragstone lime may be said to be of a very strong nature, it will not take so great a quantity of sand as most other limes; two parts of sand by measure to one lime, is the proportion generally used. If an excess of sand be employed, the mortar becomes short, and drops from the trowel. Mortar made from ragstone lime never exhibits those properties common with the chalk limes, and technically known as "fatty."

A concrete of ragstone ("Beton"), and ragstone lime, is much used in this part of the county; the stone is broken small, no piece larger than a hen's egg, with half its bulk of sand added, a quantity about sufficient to fill up the interstices of the stone. The usual proportions may be stated at six parts of stone, two of sand, and one part of lime. It is needless to say that the lime should be well burnt, ground, and used hot. A very good practice is to dispose the broken stones and sand in layers, alternately, with lime, in the proper proportions of each, then to be picked, and twice turned over, and a sufficient quantity of water added to reduce the mass to a proper consistency. In other respects the use of ragstone concrete is subject to the same regulations as concrete made from ballast.

Prices.—Subjoined is an average list of prices of stone of various kinds in the quarry, and the rate at which it can be supplied in London alongside the wharf, together with some prices paid for labour upon the stone:—

	At Quarry.			In London.		
	£	s.	d.	£	s.	d.
Rough rag, per ton		1	6		5	0
Headers, per ton		8	0		12	6
Rag for breaking, per chord		1	6		5	0
Rag for lime, per chord		2	6		6	0
Hassock, roughly squared, per chord ..		3	0		6	6
Hassock, best, per chord		4	0		7	6
Ashlar, scapled out, per foot cubic ..		2	0		2	9
Ashlar, large scantlings .. .		2	6		3	3
Lime, per load of 36 bushels ..	1	0	0	1	4	0

It would, in most cases, be cheaper and otherwise preferable to burn the lime in London.

Prices of labour on ragstone in Maidstone.

	s.	d.
Beds and joints (usually measured as plain work)		8
Plain picked face		8
Plain close picked in a superior manner		10
Tooled face	1	4
Sunk work	1	0
Sunk and tooled	1	8
Moulded	2	6
Circular plain	1	0
Circular and tooled	1	8
Circular sunk and tooled	2	0
Circular moulded and tooled	3	6

For ragstone concrete, the quantities may be stated at eleven chords broken rag, one hundred of lime, and four bushels of sand, for ten yards of concrete. Breaking the rag may be reckoned at one shilling the chord.

FICTILE MANUFACTURES—POTTERY AND PORCELAIN.

At a meeting of the Archæological Institute, May 1, a very interesting paper, by Mr. Birch, was read, on "*Fictile Manufactures, including Pottery and Porcelain of all countries and all periods.*" The subject excited great interest, and caused the table to be covered with numerous and valuable examples of the art, from the earliest to the most recent period. Specimens of Babylonian, Greek, Roman, Mediæval, Italian, and German pottery were grouped according to date; and, to continue the series to our own time, a large case presented specimens from the collection of the late Enoch Wood, and the manufactory of the Messrs. Minton, illustrative of the progress of the Staffordshire manufactories, from the time of Queen Elizabeth to the present day. Among the contributors to the exhibition were the Marquis of Northampton, Earl Spencer, Viscount Strangford, Sir Philip Egerton, Bart., Mr. Talbot, Mr. Jekyll, Mr. Bidwell, Lady Brancker, Mr. Strutt, M.P., Mr. J. W. Burgon, Mr. Dilke, Mr. Whincopp, Mr. Cole, Mr. Mayer, of Liverpool, the Rev. H. Addington, Mr. Gowen, Dr. Bromet, and Mr. Engleheart.

Mr. Birch commenced by giving a brief, but comprehensive *history of ancient Fictile Art.* He observed that the most ancient pottery extant was, probably, that found at Babylon and Nineveh; some of this was of a fine red clay, and at the latter place varnished and enamelled ware, probably of the time of Sardanapalus, had been found in the recent excavations of M. Botta. It was, perhaps, from Babylon that Fictile Art was transmitted to the Egyptians, who appear to have exercised it at the earliest known period of their history. Vases are found in the tombs in the vicinity of the Pyramids, of a date probably 2000 B.C., of baked clay, some glazed and of various colours. The ornaments of Egyptian pottery consist chiefly of flowers; with occasionally a few human and animal forms traced in black outline, but the designs are coarse, and show little taste or invention.

Mr. Birch proceeded to describe the *Fictile Art of Greece and Italy.* The vases of the archaic period are, 1. the Athenian, of a light and fine clay; the ornaments are on a fawn-coloured ground, and consist of bands and Meander borders. Animal forms occur but seldom in these designs—the human form never. 2. The black ware, ornamented with figures in relief, found throughout Etruria; and which we must consider the work of the Etruscan people, from about 660 B.C. to 416 B.C., when their power began to decline. The subjects of these vases are the most early Greek myths; some of the figures exhibiting monstrous combinations, borrowed from the oriental religions, and to be met with on the Babylonian cylinders and in the art of Persepolis. The material of this ware is black throughout. Besides this class of vases, the indigenous product of Etruria, we find in that country specimens of the Fictile Art, imported by the Greek settlers, and resembling the vases found at Corinth by the traveller Dodwell. These are known by the name of Nolan-Egyptian or Phœnician. The ground of this ware is a pale straw colour, with animals painted in maroon; the details and inner markings being given with the point of the graver, and some accessories picked out with crimson. The date of these vases is probably from 600 B.C. to 540 or 520 B.C.,—corresponding with the mythic arrival of the Greek potters, Eucheir and Eugrammos, said to have been brought to Etruria by Demaratus, from Corinth. To these earlier specimens, succeed the vases with black figures laid on a light ground. These are made of red clay, tinted with an orange-coloured varnish: the design was drawn in slight dark outline, or traced with a point, and the whole internal part of the figure filled up with black. The light inner markings of the figure were then incised on the black pigment with a graver, which cut down to the yellow ground of the vase itself; the accessories being picked out with purple and white, as in the class last described. These vases are often accompanied by inscriptions recording the name of the artist, the maker, that of the person to whom dedicated, and of the personages represented,—which are particularly valuable as evidence of the early forms of the letters.

The subjects of these vases were all taken from the most ancient Greek legends,—the Capriaca, the Iliad and Odyssey, the Hymns of Homer, and the works of Alcæus and other early Greek poets. The figures on them are still drawn in the archaic style, and resemble those on the early coins of Sybaris, Caulonia, Tarentum, and other places in Magna Græcia. This class of vases is found associated with Etruscan art and inscriptions in the tombs of the Etrurian Lucumos. They also occur in Greece Proper,—but with certain differences of fabric which forbid the supposition that they were all manufactured there, and imported thence to Etruria. It is more probable that, while those found in Greece itself are the indigenous product of that country, the Italian vases were the work of the Greeks who settled in the Etruscan cities.

Second Period.—After the above archaic period, succeed the vases of the best time of *Greek Art, from the epoch of Phidias and Polygnotus*, B.C. 470, *to the archonship of Euclides*, B.C. 404. These vases have red figures on a black ground. The material, like that of the earlier vases, is a fine red clay. The artist, having traced out the design, then filled up the whole of the background with the black pigment, following the contours of the group. The inner markings of the figures, which in the former style had been incised with the graver, were sketched in with a brush dipped in the black pigment which formed the ground. This change in the technical process gave scope to the freer and more refined treatment to which the Art of the period had attained.

The subjects of these vases are apparently suggested by the works of the great painters of the day. They chiefly represent myths; historical subjects are rare, and seldom of later date than the time of Cyrus. Representations of Crœsus on the funeral pile, Musæus, Anacreon, and the Athenian Codrus, have been found. In the inscriptions of these vases, the use of the E and O, instead of the H and Ω, affords a strong presumption that their date is earlier than the archonship of Euclides, B.C. 404,—the recorded epoch of the introduction of the double letters into the Greek alphabet. The finest specimens of this style are from Campania, Canino and Vulci. Of the Athenian school of pottery contemporary with these vases we have examples in the *lecythi* buried with the dead, and the *alabastra*, or phials for unguents, so called from the material of which they were originally made. They are of a fine red clay, covered with a white pigment, on which designs were traced in black, sienna, brown, or scarlet. The subjects of the *lecythi* are, principally, the meeting of Electra and Orestes at the tomb of Agamemnon, and other scenes from the Oresteid of the three tragedians. On the *alabastra* are represented the meetings of Athenian ladies and their lovers. Besides these kinds of pottery, the vases with red figures on black grounds are also found at Athens,—but are not so peculiarly the product of the Attic school.

The *third period of Greek Fictile Art* may be considered to range from the close of the Peloponnesian was, B.C. 404, to the time of Alexander the Great, B.C. 333. To this time belong the fine vases of Apulia,—particularly those of Ruvo, the ancient Rubastini. Among the most beautiful examples may be mentioned the vase of the potter Meidias, in the British Museum, with the subject of Castor and Pollux carrying off the daughters of Leucippus,—the vase with the subject of the Toilet of Aphrodite, belonging to Mr. Rogers,—and that with the myth of Dionysos and the Camel, the property of the Duke of Hamilton. The design, in these vases, is characterized by greater freedom and technical skill in drawing, and more complexity of grouping; the lines of the composition are more flowing and luxuriant.—This fertility of invention and dexterity of execution immediately preceded the complete decadence of vase painting. In that part of Italy now called the Basilicata, a coarse style arose after the time of Alexander the Great;—the extant specimens of which enable us distinctly to trace the progressive decline of the art. Clumsy, full forms, like those of the Flemish school of painting, were substituted for the graceful proportions of the earlier Greek style; the ornaments are crowded and ill designed, and the subjects almost limited to the Dionysiac rites,—then very prevalent in Italy. The taking of Syracuse, by Marcellus, 212 B.C., may be considered the final epoch of the art of Greek vase painting; after which time it is probable that the manufacture of them ceased.

From a survey of the history of Greek Fictile art, it appears that, in each successive period, the subjects represented on the vases were supplied from the myths commemorated in the popular poetry of the day. It is remarkable, that the epoch when the art of vase painting ceased is distinguished in the history of the Greek mind by the extinction of poetic invention, the corruption of taste, and the decay of ancient faith and regard for national tradition. It would seem that Fictile Art obeyed the general law of national decadences; and that when the subjects of the vase painter ceased to be of popular interest, his art was no longer needed.

Mr. Birch illustrated his remarks by the fine collection of Greek vases on the table before him; and, after describing the painted vases, called the attention of the meeting to three fine examples of the black Greek ware of the latest period from Benghazi, the ancient Berenice, near Tunis,—one of which had an inscription of palæographic interest. These rare specimens were exhibited by Mr. Bidwell.

Mr. Birch then proceeded to give an account of some varieties of Roman ware found in this country. 1st. The so-called Samian or red ware, apparently imitated from the fabric of the early Etruscan black ware. It is ornamented with reliefs, the whole vase being either cast in a mould, or portions of embossed work laid on the plain surface. The clay is red, and apparently an artificial compound; it is generally glazed. The reliefs are commonly hunting subjects, but are sometimes mythological. This ware is found in great abundance in Italy and throughout the Roman provinces. It is called by the Roman writers Aretine ware, from Aretium, or Arezzo,—where a celebrated manufacturer of it continued probably till the 8th century, A.D.—This ware is generally stamped with the name of the potter, who appears to have been of servile condition, and occasionally of a barbarous race. The recurrence of the same potter's name in the specimens found in England, Holland, and other parts of the Roman Empire, would lead rather to the inference that it was all issued from one or more great central manufactories in Italy; though it has been strongly maintained that the specimens found in Britain and other provinces were the product of native potteries. Specimens of this ware were exhibited by Sir Philip Egerton, Bart., from Northwich, in Cheshire,—where a Roman pottery is supposed to have existed,—and also by Mr. Talbot.—Mr. Birch proceeded to point out and compare a variety of specimens of the coarse yellow, dark blue, unglazed red, black, and light red terra-cotta Roman ware,—chiefly from the collection of the Marquis of Northampton.

Some interesting examples of *Celto-Roman ware*, recently discovered at Harpenden, Herts, were exhibited by the Rev H. Addington. Mr. Birch pointed out the distinction, in fabric and material, between these works of the Romanized Britons and the genuine British ware of ruder and coarser character, found in barrows. Excellent types of the latter were exhibited by E. Strutt, Esq., M.P., and by Sir Philip Egerton, Bart.

Among the specimens illustrative of *mediæval pottery* may be noticed a remarkable fragment from the collection of Mr. Whincopp. It appeared to have formed part of a vessel ornamented with a Gothic architectural design, in high relief, and bore a very brilliant green glaze.

The specimens of *Maiolica, or Faenza ware*, contributed by Mr. Mayer, of Liverpool, and Mr. Gowen, were numerous and good. The Secretary, in alluding to them observed, that Dr. Klemm, of Dresden, was of opinion that this ware was first made subsequently to the introduction of Chinese porcelain into Europe, by the Portuguese, in 1518. The earliest manufacture was at Faenza; but Urbino and Sienna became afterwards celebrated for it. It has been supposed that many of the designs are from the hand of Raffaelle himself; but although a letter from the great painter to the Duchess d'Urbino has been cited, stating that the drawings ordered by that princess for porcelain were in progress, it is probable that most of these subjects were furnished by engravings after the great masters. Mr. Mayer also exhibited some curious landscapes in terra cotta, which he purchased in Calabria, where they were made; but he had not been able to ascertain where the manufacture was situated, except that it was in the "interior." Mr. Octavius Morgan, M.P., with reference to these specimens, made a few remarks on the terra-cotta decorations of the Fürstenhof at Wismar, in Mecklenburg,—which he considered to be of Italian workmanship.

The discussion was closed by Mr. Cole; who observed upon the examples illustrating the progress of the Staffordshire pottery, ancient and modern, procured by Mr. H. Cole from an extensive collection made by Mr. Enoch Wood, a cotemporary of Wedgewood—and from the works of Messrs. Minton. Among the modern specimens were a copy of the Portland Vase, moulded the size of the original, and reduced by firing; a Sleeping Figure, after Dresden China, with lace introduced; Encaustic Tiles (of the revived manufacture of Messrs. Minton) of three colours, similar to those making for the new Houses of Parliament;—and other interesting specimens of this branch of our native manufactures.

Sir Philip de Grey Egerton communicated an account of the *discovery of a sepulchral urn in a tumulus on Delamere Forest;* it is of earthenware, apparently slightly baked or sun-dried. The marks of the lathe are visible in the interior; but, for want of support while the material was soft, the form of the vessel is not symmetrical. Its largest circumference is 2 ft. 11 in.; diameter of the foot, 5 inches; height, 1 ft. 1 in. It is rudely ornamented on the upper part with parallel lines drawn diagonally in various directions.—Mr. Willement sent for inspection a plaster cast from part of the iron-work which formerly inclosed the monument of Queen Eleanor, in Westminster Abbey. Although rough, it was sufficient to show the great beauty of the original. A general sketch of the whole screen is given in "Carter's Ancient Architecture," Vol. 2, pl. vii.,—in which the juxta-position of the several varieties of patterns is shown. Mr. Willement considered this work to be quite equal in design and execution to the more celebrated iron-work on the doors of Notre Dame, at Paris; and expressed a hope that, at the recommendation of the Institute, the Dean and Chapter of Westminster might be induced to restore this beautiful work of Mediæval Art to its original situation.

THE GAUGE COMMISSION.

Analysis of Evidence given before the Royal Commissioners appointed to investigate the subject of the diversity of Railway Gauges.

Robert Stephenson, Esq.: Witness's father, Mr. George Stephenson, was chief engineer of the Manchester and Liverpool Railway, completed in 1830. The gauge of 4 feet 8½ inches was adopted by his father, as it was the original gauge of the railways about Newcastle. The Manchester and Liverpool was the first line in this country worked by locomotive engines. After the Liverpool and Manchester had been established, it was considered imperative that all the lines in that neighbourhood should be of the same gauge.

It is difficult to say where a break of gauge in the northern lines could have been made with the least inconvenience, as it involves the question where is the line of minimum traffic.—When travelling on the Manchester and Liverpool Railway, before laying the gauge of the London and Birmingham, it appeared to witness, as an engine-builder, when called upon to construct engines of greater power, that an increase of three or four inches in the gauge would have assisted him materially, but since, the improvements in the mechanism of the engines have rendered that increase quite unnecessary; they have ample space and to spare. In the arrangement of the machinery, which is the main question, having reference to the width, the working gear has been much simplified, and the communications in the most recent engines between the eccentric and the slide valve have been made direct communications; whereas formerly it was made through the intervention of a series of levers which occupied the width. With reference to the increase of power, the size of the boiler is in point of fact the only limit to the power, and they have been increased in length on the narrow gauge; the power is increased by increasing their length both in the fire-box and in the tubes; in fact the power of the engine, supposing the power to be absorbed, may be taken to be directly as the area of the fire-grate or the quantity of fuel contained in the fire-box. No inconvenience results from lengthening the engines to their present extent, and their steadiness is increased; they are at present 12 feet between the front and hind axles. The increase of length between the axles renders the engines less liable to get off the rails; the short engines on four wheels were liable to violent oscillation when meeting any inequality, the front wheels being sometimes actually lifted off the rail; believes the accidents on the Brighton line and on the Brentwood inclined plane were attributable to this pitching motion. The thickness of the crank of the original engine on the Manchester and Liverpool was 8½ inches. There were various plans of reversing the engine at that time. Every engineer, in fact, at that time, had his own plan; some were extremely complicated, requiring time for the reversing to be effected; they moved in fact, the eccentric. For a long time they moved the eccentric, which slipped upon an axis, and thereby moved the eccentric from one side of the axle to the other, and consequently reversed the engine; but it required a lateral motion of something like 3½ inches; and there being two eccentrics, of course, the mere act of changing the gear occupied 6 or 7 inches of the axle, independent of the more bulky construction of the apparatus itself. The long engines, if kept within 12 feet, are not more likely to get off the rails at curves than short ones.

The resistance in passing round curves is materially affected by the width of the gauge. In the collieries about Newcastle, where the 4 feet 8½ gauge prevails, wherever they come to any mining operations where the power to be used is that of a horse or man, they immediately reduce their gauge, because they want to go out and in amongst the mines with very sharp curves, and the wide gauge would be quite impracticable amongst those. In fact, the small carriages that are used in the mining operations are upon a gauge of about 20 inches, and they go round curves under ground of about 10 or 12 feet radius; and they could only work such mines by such a gauge. It is quite obvious that the width of gauge must limit the curve. In the case of every gauge at a sharp curve, the outside and the inside rail are quite brightened by the sliding motion, because the one set of wheels has to slide forward to keep pace with the other, and the others have to slide backward. In fact, when going round a curve, both operations have to take place,—the sliding backward of the one set and the sliding forward of the other. Of course, as you increase the width of the gauge, the difference between the two becomes augmented.

Is chief engineer of the Northern and Eastern Railway, and was at its construction. Adopted the 5-feet gauge in consequence of its being brought into connection with the Eastern Counties line, which had been laid down with that gauge by Mr. Braithwaite, and with the same view he laid down the 5-feet gauge on the Blackwall, in case there should be connection between them hereafter. The gauge of the Northern and Eastern and Eastern Counties lines has recently been altered under his direction; when the extension of the Northern and Eastern was considered, and that junction with the narrow lines in the Midlands would take place, a change was thought absolutely necessary, and the same change was also decided on for the Eastern Counties, from the inconvenience of blending two gauges at the Shoreditch station; the expense of a separate carrying establishment would have been greater than the cost of alteration, which was £52,000. Of course it involved the necessity of working upon a single line of rails; the establishment was divided into two parts, one of which was retained as available for the 5-feet gauge, whilst the other half was altered to be ready to work upon the other line, which had been converted into the 4-feet 8½ in. gauge, therefore the alteration from one gauge to the other was to take place in one night, in fact, between the two trains, the last at night and the first in the morning. The whole distance was 86 miles. The operation occupied about six weeks altogether, but preparations were made beforehand. The alteration was made entirely under his superintendence, and the rails being on transverse sleepers facilitated it materially. No new rails were required, and the boilers being of the same size as those on the 4 feet 8½ in. gauge, the engines could be converted.

Considers it would be advisable to run the same carriages from Euston-square to Edinburgh and Glasgow, were a railway complete. There are men at different stations to see that nothing is wrong, and the carriages, both for passengers and goods, are now so substantial, that they may run many thousand miles without anything but greasing. Goods wagons go at less velocity, and would probably stand it better. The carriage is now much more judiciously constructed than formerly. The strength of carriages conduces very much to safety in case of accident, and the plan of making the under frames of carriages of wrought iron instead of wood, will be carried out to prevent the harm at present done by splinters. Is projector of the Chester and Holyhead Railway, and will use the 4 feet 8½ inch gauge, that carriages may run from Euston-square to Holyhead; any change would interfere with communication to Ireland. His father and he were consulted as to the lines from Antwerp to Brussels, and from Liege to Ostend, and he was connected with the Leghorn and Pisa, and recommended the 4 feet 8½ inch gauge, as it had been found in this country to answer every purpose. An inch or two, more or less, would have involved a different construction of engines, and he saw no reason for altering that which had been established by experience. Was consulted on the Belgian Railways and on the Leghorn and Pisa. When giving his opinion as to the Belgian lines, the Great Western was not opened, but in reference to the Italian line he had seen both gauges in operation.

Is not aware of any advantage the Great Western possesses, and it has several disadvantages; the additional expense of construction, as in embankments, cuttings, tunnels, bridges, and viaducts, and also in carriages, engines, tenders, workshops, and stations, everything being on an increased scale. The sliding-frame system has to be introduced instead of turn tables, so that the management of the station is more expensive. Thinks the tear and wear of the carriages on the Great Western is as much as on the narrow lines, and the resistance of the wide carriages is greater; there is more friction of the wheels on the rail to be overcome. The increased expense of the carriage department on the wide gauge would not be in the haulage per mile, but in the fixed establishment of engines. Even the increased boiler (4 feet 9 inches) of the Great Western would as nearly as possible go into the narrow gauge. While he thinks the Great Western has no advantages by the wide gauge, its introduction has involved the country in great inconvenience; if a meeting of gauges takes place in the midst of great traffic, canals would have a decided advantage over railways; the system of boxes and loose-bodied wagons for the transfer of coals has been tried and failed. The loose-box system involves the necessity of increasing the number of carriages on the railway very materially. At Erewash the coal-owners could not avail themselves of the railway, and sent the coals by canal. Coal-owners would prefer transferring their coals from railway to canal, to moving them from one railway to another, on the loose-box system, as by the latter they would lose control over their boxes; they would prefer the transfer by hand, from one railway to another, to loose boxes. The American railways are universally of the 4 feet 8½ inch gauge. There is a railway from Basle to Strasbourg of 6 feet 3 inch gauge, but parties there deeply regret the alteration, as they look forward to a transfer at each end. There is a line laid down by Deridder, from Ghent to Antwerp, of 3 feet 9 inch gauge; travelled with him on part of that line from Brussels. Has seen at the Paddington terminus the modes proposed to supersede the necessity of removing goods and passengers at the junction of different gauges, and believes it would answer the purpose as far as machinery could, but seeing one or two transferred does not convey the amount of inconvenience incident to transferring 100 coal wagons. The other mode of transferring by running the train on another set of trucks, would increase the dead weight to be drawn, so as to be highly objectionable, and the increased height would prevent some classes of goods from getting through the bridges and tunnels. The London and Birmingham goods-wagon, properly laden and placed on the Great Western truck, could not pass under their bridges. The expedient at the Great Western terminus for diminishing and widening their gauge of wheels may be safe, but being complicated, he thinks it would not keep in good order; it would also be an expensive arrangement. A modification of the sliding axle was tried on the Newcastle and Carlisle, and soon abandoned. Has not been able to think of any expedient to avoid a transfer; he has seen various ones contrived; the one by Mr. Harding, of the Bristol and Gloucester, is as good a mechanical expedient as any, but that would be so objectionable as to lead to the actual transference of goods in preference. An arrangement at the Birmingham termini for lifting goods wagons from one level to another is the simplest operation, but if they had to be put on different wagons, the evil would be very much aggravated; even with regard to Birmingham, the inconvenience of the lift is so great, that it is to be abandoned, and an inclined plane substituted.

Is still a locomotive engine-maker, and is of opinion that the 4 feet 8½ inch gauge gives ample space to get the utmost power necessary for working ordinary trains; at present there are, he believes, more powerful engines working on the narrow than on the broad-gauge lines. The cylinders of those engines are 16 inches in diameter, the length of stroke is 24 inches, and the wheels vary from 4 feet 6 to 4 feet 9 in diameter. They are all six coupled; and those engines are as heavy as the present rails will bear. They weigh from 22 to 23 tons; I believe the same weight as the Great Western engines. There is now as great a weight upon six wheels upon the narrow gauge as ought to be put upon 6 wheels; and that will be hereafter the limit of power, not the width of gauge; engines may be built upon the wide gauge, no doubt, heavier and larger in dimensions, and more powerful, but then you must make a road to support it on purpose. The weight of the rails is 75 pounds to the yard; 65 have been used. The width between the bearings varies from 3 ft to 2 ft. 9. Thinks the narrow-gauge lines best calculated for carrying weight without injury to the road, and the transverse-sleeper system is better for keeping the rails in order than the longitudinal bearings. The expansion and contraction of the iron tend to disturb the action of the sleepers. Instance on the Peterborough line, where the rails had been laid too close, and acted on by the heat of the sun, raised the sleepers three feet into the air. Locomotives can be manufactured for the narrow gauge capable of attaining as high velocities as those on the broad; they are now running upwards of 50 miles an hour, with engines not made for maximum speed. No difficulty in making a narrow-gauge engine to take 40 tons at 60 miles an hour, or more; the engines on the Great Western were made for greater speed, but the average on it was the same, or a little under the Northern and Eastern.—The average speed of the Great Western is greater than on the London and Birmingham, except for mail trains, which are precisely alike.—Has worked the express trains on the narrow lines with as much economy of coal &c., as on the Great Western. The express engines on the Birmingham are smaller than others, weighing only 12 or 13 tons, and costing about £1300.—Should recommend those weighing 17 or 18 tons, and costing about £1650. Thinks the public safety would be endangered by having the bodies of the passenger carriages moveable at a change of gauge; any slight collision, not otherwise dangerous, would throw them off, besides the risk of porters neglecting the fastenings of each.—Would never incur the responsibility of having the bodies separate from the under frames, as, besides other objections, the under frames would be more liable to derangement.—The complexity of the broad and narrow gauges in the same station would be great; the turn-table, a most invaluable machine, must be abandoned.—Combining two gauges, by laying the rails of one centrally within the other, would get rid of some of the difficulties, but not at stations. Turn-tables could be used, but already in the wide-gauge system they are beyond the pale of turn-tables, from the distance between the fore and aft axles of wagons.

In changing from a narrow to a broad-gauge line, believes the least evil is to transfer everything, changing the carriages and moving the goods by hand; with reference to general merchandize, has heard Mr. Brunel express the same opinion. Thinks it would be better to have two rails for the narrow laid within those of the broad gauge, than to have only one, and to use one of the broad gauge rails; as in the latter way, the two trains could not accompany each other, the centre of gravity not being on one line. If the engine were at the head of the trains, it would be of less consequence than if they were propelled from behind. A double system would be required to drive each carriage from the centre, and this is a matter of serious expense. Witness would lay down the narrow within the broad gauge, on the transverse sleepers, and the cost would be about 4000*l.* a mile, or more, in addition; Mr. Brunel estimates a single line additional at 2500*l.*, besides the extra cost of station. This is on the supposition that the broad gauge is first laid down on transverse sleepers, but the expense would not be materially different in either case. The rails would not be packed well with longitudinal sleepers, on both systems. In adding a pair of rails within the broad-gauge, witness would lay down the transverse sleepers independently; for with other longitudinal sleepers, there would not be room for another bulk like the present, and the ballast of the weight would not be in the centre. Could not mix the systems of sleepers, on account of the length of the transverse, which would almost cut the longitudinal in two. It would be impracticable to lay down the broad on the narrow gauge, without sacrificing one line in tunnels, which would, from danger, amount to a prohibition. On the narrow gauge 24 feet are required for tunnels, and on the Great Western 4 feet to 6 feet more. Four feet is the minimum space between the two, just room for a man to stand, and the same spaces at each side of the tunnel, and any diminution would be fatal. Recesses might be made at intervals, to meet a diminution, but a man might not be near a recess when the train came. Recesses could be made after the tunnel is formed, but in many cases the brick-work would thereby be much injured. Impossible to place the broad gauge on the London and Birmingham, without enlarging the tunnels and closing the line for two or three years. Would rather make a new one than enlarge the present Kilsby tunnel. A cutting could not be kept open there, and it would be a gigantic work. With reference to the present and future meeting of the broad and narrow-gauge lines, does not apprehend much interruption to the express and other passenger trains at the points of junction, if they are made at the proper places; thinks Bristol and Oxford two places where the two gauges ought to meet, as at these two points he believes there is the least quantity of cross traffic; this explained by witness.

The principal Midland Counties traffic, from Rugby to the Great Western, supposing the double line were constructed from Oxford, would be coals going towards Oxford, and corn coming back. Looking to Southampton as the port, it would only require, supposing the narrow gauge carried down to Oxford, a line from Oxford to the South Western to complete the narrow gauge system over the kingdom, as far as Southampton is concerned; the Great Western Company have a line from Reading to Basingstoke, and if that were laid on the narrow gauge, and the double system from Reading to Oxford, there would be no break in the country at all; commercially, Southampton, London, Bristol, and Liverpool, would interchange with each other, and with the manufacturing districts, by the same carriages. No extension of the wide gauge towards the London and Birmingham would relieve Lancashire or Yorkshire from a change of gauge, but an extension of the narrow from Oxford to Basingstoke would relieve the whole question of embarrassment. The Great Western Company can be compelled to lay down the double gauge from Rugby to Oxford, and on the greater portion from Wolverhampton to Oxford, and to Worcester, as they agreed to do that. The loss of time in transferring a passenger train at Rugby to go to Oxford on the broad gauge, would depend on the amount of passenger traffic; it is a point of small passenger traffic; it may be a large one of coals and corn; the extension of the wide gauge into that district must multiply the points of junction of the two gauges, and the chances of interruption: passenger trains could not be changed in less than half an hour. Has experienced the inconvenience of changing carriages, and scrambling for luggage on the Belgian railways, at Malines. Was detained the last time about half an hour. If the change of gauge took place at Rugby, a new station would be required.

With regard to agricultural traffic, at any point of change, the beasts would require to be grased before removing them from one carriage to another, and is afraid the loose bodies would be required for pigs; they could not be managed otherwise; they must be lifted *en masse.* The wagons themselves upon the narrow gauge vary from 2 tons 10 cwt. to 3 tons; some recent large ones run as far as 3 tons 10 cwt., and they will carry 5 and 6 tons of goods. I think the latter is as near two to one as possible; that is, that if the dead weight is one, the useful weight is two. The difference is here against the broad gauge; the trucks for intermediate traffic seldom average more than a ton each, so that all the intermediate traffic on the Great Western is carried on with trucks of five tons, with one ton of goods in them. As railways extend into every corner of the country, the advantages of the narrow gauge would be most apparent, and as the wide is more expensive than the narrow, the former would limit the ramifications of railways. The narrow gauge wagons are infinitely superior for mineral traffic, particularly coal; if the mixed gauge system be allowed to extend in this country, the charge on coal will amount in many cases to a prohibition. Thinks the broad gauge has a disadvantage as to horse-boxes; their motion is sometimes fearful; they want length with reference to their width, while on the narrow gauge a carriage of the same length might be very steady. Prefers the narrow gauge passenger carriages, carrying three in width, to those of the wide, carrying four; the latter are cold in winter, and want ventilation in summer. There has not been so much attention paid to the construction of the narrow gauge passengers carriage as to the broad, but the narrow could be made 6 feet high, so that a person might stand up in them. The lowest longitudinal distance between the axles of 4 and 6-wheeled engines on the narrow gauge, is 10 feet, and the highest 12 feet 9 inches; the last are too long; witness adopts a maximum of 12, and a minimum of 10 feet; relatively the centre of gravity is the same height in both gauges. Though there would be great difference as to the cost of constructing the broad and narrow lines, cannot say there is any difference in the cost of working. Whether the traffic be much or little, it is merely a question of expenditure of power, and though the most powerful engine is cheapest to work with a proportionate load, each may have engines of the same power.

The wide gauge engines are not more powerful, but are heavier in proportion to their power; everything in the width gives the engine no power at all, but is an encumbrance. Neither commercially nor mechanically has the wide gauge any advantage over the narrow, but rather the contrary. The driving wheels of the broad gauge engines are not generally of greater diameter than the narrow; 6 and 7 feet engine wheels are used on the Great Western. The greater diameter of the driving wheels has a tendency to reduce the axle friction; but comparing 6 and 7 feet, the amount of this is not worth measuring, but if by increasing the gauge, the axle has to be increased in size for strength, what is gained on the one hand is lost on the other. The friction of the flange of the wheels against the railway has a retarding effect on curves, but not much on straight lines. Any lateral friction arises from the angle of the wheel against the line, and must be greater on the wide than the narrow gauge; round curves the sliding motion must be directly as the width of the gauge.

The evaporating power of a passenger engine, on the Northern and Eastern, is about 180 cubic feet an hour; he has some evaporating 160 feet. The most powerful engines are constructed with either outside or inside cylinders; the largest are inside. Certainly, some engines that have been recently made with outside cylinders have too much of that motion than I like. It is exceedingly difficult to say how the motion is produced; if you consider the action of the cylinder, it is perfectly rigid metal—engine and cylinder altogether. Now, when the steam presses upon the piston, it is at the same time pressing against the lid of the cylinder; the action and reaction must be equal. Therefore, that it is not the steam that causes the irregular action, but the mere weight of the pistons themselves, and therefore if we could contrive to balance the pistons by the weight upon the wheel, we should get rid of that very much; but in the most recent designs of engines of that kind, he has brought the cylinder much nearer to the driving wheel, and nearer to the centre of the engine; at present they hang over the wheels a good deal; now he has brought them within the wheels.

It is now an indispensable part of the broad-gauge system to use the longitudinal bearings; it is a question of expense. As you increase the width of the gauge, of course, on the longitudinal system, it leaves the expense the same; whereas, if you adhere to the transverse system, you increase the size, and, of course, you increase the expense more rapidly; therefore the transverse system with a very wide gauge would be very objectionable on account of its expense, but I think the principle of construction would be better. With reference to the maintenance of the way, imagines that the way is kept in better order upon the transverse system than upon the longitudinal at the same expense; has never seen any portion of longitudinal bearing railway in perfect order. It is more difficult to pack, and there is always more friction in a longitudinal railway than in a sleeper railway. The Hull and Selby is part of it longitudinal and part of it transverse. The engines, where they were heavily laden, upon the longitudinal bearings would just creep along; the moment they got to the transverse bearings they went 5 or 6 miles an hour more directly, from the yielding in one system, which gives a little less noise and a little softer motion which the Great Western has. Does not think that in that particular case it resulted from the longitudinal bearings being of insufficient dimensions and slighter than the Great Western, thinks they were the same size;—Memel balks, 12 or 14 inches square, cut up; and the Great Western are 14 inch balks. In the longitudinal system there is a little less noise, and there is a little softer motion than upon the transverse system, but there is a great deal more motion; there is far more actual motion upon every longitudinal railway than upon the transverse sleeper system.

If the London and Birmingham had originally been made on the broad gauge, estimates that it would have cost about 3000*l.* a mile more, without including the additional cost of the central station at Wolverton, which must have been much larger. As to altering the existing gauge on the London and Birmingham, thinks as it would stop the line for at least two years, that it is practically impossible. It would cost about 15*l.* a yard for tunnelling, taking good ground and bad. To make the Kilsby tunnel as large as the Great Western tunnels, it would have cost a great deal more than that. On the other hand, in increasing the size of the tunnel in good ground, such as chalk, the additional cost would not have been so much. States the results of experiments, showing the consumption of fuel and water, by an engine with different load. Found that the consumption of fuel for drawing the engine without a load, was equal to about the consumption of fuel to overcome a load of 15 carriages at 30 miles an hour; that is, it took as much to move the engine and tender as it did additional to move 15 carriages. There have been many reasonings upon that without considering the precise application of it. A large proportion of the fuel in moving the engine alone is consumed in overcoming the resistance of the atmosphere to the pistons; it will not require more than three or four pounds to overcome the friction of the engine and tender proper, but it requires 15 pounds in addition to that to overcome the engine and tender, taking into account the atmospheric resistance to the piston; so that there is always 15 pounds of pressure of steam in all high-pressure engines absolutely lost; it is not the friction of the engine; certainly it is a defect in the engine from its being a high-pressure engine, but on no other account. It is not a peculiar loss applicable to locomotive engines alone, but to all high-pressure engines; and therefore in estimating the consumption of fuel and dividing the proportion of expenses, it became important to ascertain what was the relative expense of conveying 8 carriages, and of conveying 15, because all the trains of the Croydon Company were small, and all the trains of the Dover Company were comparatively large; and from this experiment it appears that as to the cost of coke, whether to convey 8 carriages or 15, there is a very small difference. Therefore, if you proportion your expenses by the load, you give the small load very greatly the advantage, because you charge them only half the fuel, say as 8 is to 15, whereas you ought to charge them as 8 plus the engine is to 15 plus the engine, which will make a very great difference.

Believes the gauge of the Dutch railways, constructed in 1842, to be 6 feet 5½. The Amsterdam and Haarlem Railway is essentially level, and laid on longitudinal timbers, which are best suited to the unsound ground of Holland. The line laid over Chatmoss is laid on transverse sleepers, but the moss there has much more tenacity than the substratum of peat in the low part of Holland. Mr. Conrad constructed or projected the line in Holland; he examined railways in this country, but does not know whether he was assisted by any English engineers.

Joseph Locke, Esq.—Is the engineer who completed the Grand Junction Railway. This line was opened to the public in 1837. When witness assumed the office of engineer on this line, the rails and sleepers had been contracted for, the bridges designed, and some portion of the work commenced for the narrow gauge. Alteration of gauge at this time would have been attended with considerable expense; narrow gauge selected for this line because surrounded on all sides with lines of similar gauge, and it was desirable to preserve uniformity of gauge in the district. Great Western Railway not commenced at this time. Narrow gauge rails may be laid down on a broad gauge railroad, so as to carry on the narrow gauge traffic continuously; this process is very expensive, and in reference to the stations, very inconvenient. Where two gauges meet, the station by this plan must not only be made larger, but also of a different construction than if made for one gauge only. If called upon to project a series of railroads in a new country, would prefer an intermediate gauge, between 4 feet 8½ inches and 7 feet; wide gauge not necessary for machinery; carriages on narrow gauge lines can be made longer and loftier than at present, giving as much space to each passenger, three on a side, as in broad, as four or five on a side.

Height of carriages on narrow gauge lines lately increased 6 or 8 inches. At high speeds higher wheels are necessary; the centre of gravity would consequently be raised, rendering wider gauge than 4 feet 8½ inches desirable; at the same time, witness is of opinion, that looking to the construction of the road, the speed now attained is as great as is consistent with safety, and would neither increase the gauge, speed, nor size of wheels without more experience in the construction of engines and strength of materials; inequalities of road from change of temperature and weather impossible to be overcome; some engines on South Western Railway with wheels 6 feet 6 inches diameter, where the boilers are not higher than on engines with wheels of 5 feet 6 inches; this done by placing the cylinder outside the boiler, and bringing the boiler nearly on to the axle; the centre of gravity as low with the large wheels as the small ones by this arrangement. No disadvantage caused from this change; application of power outside the wheel does not produce a rocking motion. Great changes have been made on engines on narrow gauge lines, with a view to obtain increased power; engines of enormous power have recently been constructed on North Midland Railway to carry heavy trains of minerals. Limited space between wheels and boiler in engines on narrow gauge lines caused some inconvenience in the attempts to obtain increased power. Turned his attention to improving the engine and altering the arrangement of machinery; and now gets all necessary power on narrow gauge lines. Length of boilers on Grand Junction and South Western lines increased from 8 feet 6 to 9 feet 6.

Cannot tell the velocity attained upon the Great Western; express trains on South Western line travel 40 miles, and could no doubt run 50 miles an hour. Does not think 50 miles an hour can be done with safety on any line that witness has been on; is much opposed to such excessive speed. Curves more difficult to traverse with broad than narrow gauge. Facility for turning curves in inverse ratio to the width of gauge.

Broad gauge gives greater facility for conveyance of heavy trains, by giving larger space to put the power in, but witness considers that as much and even more power than is necessary can be obtained on the narrow gauge; disapproves of throwing a large force upon one engine. Has heard of trains of 60 and 70, and in one instance of 77 wagons in one train; would altogether prohibit such trains; would divide them, and not allow more than 40 wagons, each weighing 5 or 6 tons, at one time; more than that number strains the wagons, the frames are thrown out of square, the chains are broken, and cause delay and inconvenience on the road. Would not have greater power than sufficient to drag 60 wagons; the engines on North Midland, with large boilers, cylinders, and fire-boxes, can drag 100 wagons; they generate more steam than they consume.

Wide gauge more expensive than narrow; it required longer sleepers, greater space for embankments, cuttings, &c.; Mr. Brunel of a contrary opinion; his calculations were founded upon using smaller timbers and lighter rails than he is now using. The South Western rail is 75 lb. to the yard; both the Grand Junction and London and Birmingham were originally 65 lb.; have been recently increased to 75 lb. Increased expense of broad gauge would be in bridges, tunnels, cuttings, and embankments. Outside rail of Great Western nearer the slope or ditch than upon other lines; if engines get off the lines, more liable to fall over; witness prefers a wide embankment, and where possible, always gives additional width. Estimates that a broad gauge transverse sleeper would cost 50 per cent. more than a similar sleeper on the narrow gauge. Ordinary width of embankments 30 feet, giving 7 feet on each side between edge and outer rail. In such roads, if engine got off one rail, it would remain on embankment; if off both rails, it would go over. Cannot say how far the extra width in Great Western engines would prevent them getting over the embankment. Would give a space of 7 feet beyond the rails in wide as well as narrow gauge lines.

Rails laid upon longitudinal bearings give greater elasticity to the work, and tend to throw the engines and carriages off the line; tried with longitudinal bearings two viaducts, Dutton viaduct and Birmingham viaduct, and could never keep them in order; considers the principle bad; prefers transverse sleepers. This opinion the result of actual observation. Railways laid with transverse sleepers more easily repaired than a longitudinal road.

Has not seen the contrivances used at Paddington for transferring traffic from one gauge to another. Believes the transfer can easily be made. The machine itself very simple; the practical difficulty is in use of carriages carrying loose-box bodies to be tranferred; a machine was formerly used on Liverpool and Manchester for lifting loose coal-boxes; machine excellent, and saved much labour, but the boxes were so much broken and injured in lifting, that the contrivance was abandoned; carriages with loose bodies not so strong as others; in event of collision passengers would be in more danger in such carriages. On certain French lines the diligences are put on loose wheels, placed under the frame, and with a little hoist lifted up on the body of the carriage, and put upon the truck of the railway, just in the same way as a gentleman's carriage, and taken off in the same manner, and dropped on to a frame of four wheels at the end of the journey. The contrivance is very simple and very facile; but not very safe. They take the truck as it stands when the diligence is loaded; there is first of all a truck made for the diligence. It is not a truck with a simple bottom to it, but has sides to it, and it is then like an ordinary truck; and I believe that when the diligence is upon the truck, it is certainly not so strong as if it were part of the same carriage, but it is very heavy, and they carry a weight upon the Paris and Rouen line of eight or nine tons where the diligence is loaded; and if it were not for the change, you might have a weight of only about five or six tons, so that in every carriage you are carrying a great deal of dead weight in order to avoid the necessity of changing the carriages. There was a collision on the Orleans Railway by some sudden stoppage; one of those very diligences was thrown off its position.

Engines on narrow-gauge lines are not all made with outside cylinders; on Grand Junction line, about one half are so made, and others, as they are repaired, are altered upon the new system; but even with cranked axles, the arrangements of machinery are so simplified and compressed, that no inconvenience is felt from want of space. No difference in construction of horse-boxes on broad and narrow-gauge lines. Greater speed on Great Western attributed to their having better gradients, fewer stoppages, and larger engines than on narrow-gauge. Has travelled on an engine with 6 feet 6 inch wheel (the largest wheel on narrow gauge) 50 miles an hour with ease; that engine capable of taking six or eight carriages 60 miles an hour; one of the new engines on Grand Junction, with only a 6-feet wheel, and expansive gear, recently travelled 57 miles an hour.

Believes that wherever a break of gauge occurs hereafter, either an entirely new line must be laid down, or a narrow gauge line laid upon broad gauge road. In the latter case, continuing the narrow gauge, and having the double gauge upon the shortest possible length, is the lesser evil of the two, and in all probability will be universally adopted. Break of gauge should take place where there is little traffic. An alteration of all the broad gauge lines to 4 feet 8½ inch gauge would be the cheapest mode of obviating the evil of different gauges. Believes the Great Western Company will find the inconvenience of break of gauge so great, that they will be compelled to lay down the narrow gauge from Oxford to London. Is not prepared to say at once that a change of broad to narrow gauge throughout would lead to the greatest economy, and greatest commercial advantage, because the officers of the Great Western Railway believe that the inconveniences attending a change of gauge are less than supposed by witness; could not, therefore, as a government officer, supposing all the railways now made the property of government, advise a change of broad to narrow gauge without greater experience.

Reason of engineer of Great Western Railway adopting wide gauge, after the Bill had passed through Parliament, supposed to be a desire to attain greater speed, a better road, and greater economy of construction; one great item of expense in locomotive engines supposed to be the rapid reciprocation of the piston: and to diminish this was thought very desirable; but the expense of working locomotives on narrow gauge has diminished from 2s. 6d. to 2s., 1s. 4d. down to 10d. per mile run; it is very doubtful whether the expense is not just as great on Great Western as on the narrow gauge; Mr. Brunel at first intended using wheels of much larger diameter than are used at present; wheels on Great Western formerly 10 feet in diameter; those now used only 7 feet; only 6 inches larger than those at present working on South Western Railway; the adoption of the broad gauge it was supposed would tend to diminish the working expenses; this result, however, has not yet been proved. Considers that a far higher speed can be obtained on narrow gauge lines than is compatible with safety. If desirable to change gauge of South Western to broad gauge, should take certain length, and use a single line; this is the practice when any substantial repair is in progress, when a mile or mile and a half of rail is taken up, using a single line, and keeping a policeman at each end. The tunnels on South Western line not large enough for broad gauge, and while enlarging these, the traffic must be stopped; the bridges and viaducts would also require alteration.

Has bestowed considerable attention to the construction of locomotives, particularly at the time the difficulty was first experienced in obtaining greater speed on narrow gauge lines. The first engines used on Grand Junction line of very inferior construction; the difficulty of obtaining greater speed on this line first induced witness to turn his attention to improvements in the construction of locomotive engines. Outside cylinders introduced on Kingstown and Dublin line without outside frames; by this plan the cylinders overhung the frame too much. On Grand Junction line outside frames were used, but the outside bearings were attached to the front and hind wheels only; the cylinder by being attached to the driving wheels, without the intervention of the outside frame, kept the engine more compact. By this arrangement the width of engine was diminished several inches. Inside cylinder has necessarily a crank axle, and more liable to break; on Grand Junction line, accidents from this cause formerly a source not only of expense but of danger, as the crank broke when the train was in motion, and often threw it off the line. Has not had a single accident from breakage since the introduction of outside cylinders. Engines getting off the line not of frequent occurrence; more so now than formerly, in consequence of the increased speed.

Tenders on Great Western line of greater capacity to contain water than on other lines, and run longer distances without changing. Tenders could be made for narrow gauge lines larger than those on Great Western if considered necessary; tenders upon Great Western line all upon six wheels; on other lines upon four wheels only. The 10-feet driving wheels on Great Western abandoned from the difficulty of getting engines large enough to move the trains at any ordinary speed, and the further difficulty of stopping them when once started. Wheels of these dimensions not suitable on a line with severe gradients. By increasing the size of the wheel there will be a danger of the springing of the wheel itself on its motion, from the axle not being sufficiently rigid. In going through points or crossings with a very large wheel, a very little force applied to the flange will spring the wheel unless it is made proportionately strong, and if you do that you will have a wide boss; the bosses are 8 or 10 inches, the spokes are 4 or 5 inches, tapering up to 3 inches at the rim; if you increase it from 6 or 7 feet to 10 feet you must increase the width of your boss, and you will have a very heavy weight and very wide boss. Weight of largest engine on Southampton line, about 17 or 18 tons. No evil will result to the road by increasing the weight of the passenger engines.

Wagons on either gauge can be made to contain 5 tons; in the north of England, where so much more is carried than in the south, small wagons are still adhered to. Wagons upon both lines made to carry 10 tons of coals. Narrow gauge most convenient for side lines running to the pits. Relative cost of working trains at 16 miles and at 40 miles an hour about one-third more. Some engines on Grand Junction line burn 16 lb. of coke per mile. Probable consumption of express trains about 4 or 5 lb. per mile more; on Great Western the consumption is considerably more than this; they have larger and heavier engines; on South Western line, the quantity of coke consumed per mile is considerably less than on Great Western.

There would be increased difficulty in the ordinary working as regards the maintenance of way, packing the rails, &c., if the narrow and broad gauge were combined. The easiest mode of maintaining the road would be, where you have the broad gauge, by transverse sleepers, and then putting a single rail upon one single sleeper; that is the best mode of keeping the road in repair: but it is not a good mode of laying the road for two carriages, nor is it convenient for working, because the centre of gravity is not in the same line. If you take two rails between the longitudinal bearings of the wide gauge, you have not space enough to put longitudinal bearings, unless you put them close together: and you cannot ram them; if you ram down one side you will run a risk of elevating the other rail; and in ramming down the inner rail you would run a risk of lifting it up out of the level on the opposite side; in fact, the want of the facility of getting to both sides of the baulk would be found a very serious inconvenience. Would propose, under those circumstances, to lay both rails upon transverse sleepers; and if railways were to be made in that manner, should certainly lay a large sleeper, long enough to take both gauges.

A considerable number of the transverse sleepers upon the Great Western Railway have been changed; their duration is very variable; those not well saturated decay sooner than others; their duration also affected by the nature of the soil. Construction of passenger carriages on Grand Junction line much improved; they are now made stronger and more substantial. They are now made solid instead of being carved out. This change is adopted partly from economy and partly to obtain greater strength. Liverpool and Manchester Company began with very light carriages, considering that the lighter the carriages the less the draught; on the slightest collision they got out of the square; they have been gradually increased in strength up to the present time; they now weigh about 3 or 3¼ tons, but have not yet adopted the solid frame; cost more from the quantity of iron-work used in their construction. Reasons for the adoption of the solid frame were these:—In the bolt-holes in all these small scantlings of timber not more than 4 inches square, or 4 by 3, on taking a carriage to pieces, you found a little decay; that one corner of the bolt-hole gets a little larger, and there is a little play; consequently it has to be renewed far sooner than if it had been a solid and substantial piece of timber, for the least decay in a small piece of timber renders it unfit for its work, and it must be renewed. Upon seeing this at the Grand Junction workshop at Crewe, witness advised the directors to abandon entirely the construction of the carriages on that plan, and to adopt the solid frame; and they now have carriages with solid frames. Considers the public safety much increased by the alteration. Many engineers entertain a different opinion, and consider that very high velocities may be obtained with much lighter carriages than those now used; Mr. Brunel and Mr. Cubitt are both of opinion, that by the atmospheric system, they will be able to keep the road in better order, use lighter carriages, and go at greater speed than has hitherto been attained on any of the locomotive lines. Witness altogether disapproves of light carriages, and considers that with them accidents are more frequent, and when occurring, more dangerous than with the stronger carriages. Safety of train depends greatly upon weight of engine which draws it. If the engine were a light engine, at the speed at which it sometimes travels, it would leave the rail; but, as it is heavy, it gives security to the train behind it. Recent accident on Great Western line, where all the light carriages were more or less damaged, while the strong one, in the same line, was scarcely strained. Sleepers can be renewed on transverse system at much less expense than on continuous bearings. Estimated expense of one mile of permanent way, £4,838.—

		£	s.	d.
Rails, 75 lb. per yard . . .	236 tons at £11 . . .	2,596	0	0
Chairs	56 tons „ £9 . . .	504	0	0
Sleepers	2·640 „ 5s.	660	0	0
Ballast	9,680 yards „ 1s. 6d. . .	726	0	0
Laying Road, including Spikes and Keys, 3,520 at 2s.		352	0	0
	Total	4,838	0	0

The prices of Rails, Chairs, and Ballast are variable.

(To be continued.)

AMERICAN PATENTS.

Granted in March 1845, reported in the American Franklin Journal.

MARBLE POLISHING MACHINE.

A machine for "*polishing flat plates or tables of marble.*" Jacob Ziegler, Philadelphia, Pennsylvania.

The plates of marble, &c., to be polished, are placed, face upwards, on the top of a carriage which carries them slowly under the rubber, which is a flat plate of wood or other material, covered with the polishing substance. This rubber receives a movement from two cranks or cog wheels, attached to the lower ends of parallel vertical shafts, geared together and driven by an intermediate cog wheel on the driving shaft. These shafts are hung in a sliding cross head suspended by levers, &c., to regulate the pressure of the rubber.

BRICK-MAKING PRESS.

For an "*improvement in the brick press.*" John Waite, Leicester, Massachusetts.

The improvement is for arranging and operating on the brick machine, so that while one brick is being compressed in one compartment of the mould by the compressing pistons, the discharging piston shall be performing its office of expelling from the mould the brick which had next previously been formed; the mould being progressively moved forward at regular intervals of time, so as to present that compartment of it in which the brick has been compressed to the action of the discharging piston, where the compressing pistons next enter the preceding apartment, to effect the formation of a brick therein.

TINNING PIPES.

For "*improvements in machinery for making and tinning lead pipes.*" Robert W. Lowber, Rochester, N. York.

This is for tinning lead pipes, (which are formed in a die and around a mandrel) by introducing the melted tin through the mandrel, or core, which is hollow and provided with apertures for the discharge of the tin inside the pipe.

Claim.—"What we claim herein as our invention and desire to secure by letters patent, is the method herein described of tinning the inside of lead pipes in the course of manufacture, by passing the melted tin down into the mandrel and out at the side thereof, as above made known, whether applied to this machine or any other substantially as described."

VENTILATING STOVES.

An "*improvement in stoves for warming parlours, and for other purposes.*" John Morrison, Newark, New Jersey.

The nature of this improvement "consists in taking the air from near the ceiling of rooms, for supplying air to the fire, and thus incidentally ventilating the apartment. For this purpose there is a pipe which extends up from the ash pan to within a short distance of the ceiling, where it is made bell mouthed for the free admission of air. This pipe is surrounded by an outer jacket, which communicates with the chimney, the fire chamber, and with the case surrounding the fire chamber of the stove, by separate pipes governed by dampers for regulating the draught, heat, &c.

HYDRAULIC PAINT.

An "*improved mode of making hydraulic paint.*" Thomas G. Warren, Troy, New York.

The patentee says,—"This paint is composed of 'hydraulic cement,' (sometimes called 'water lime') made fine by grinding, and 'linseed oil' to be mixed in such proportions as to make a paint of ordinary thickness. The use to which this paint can be applied is general. It can be applied to houses of either brick or wood, and also to cloth roofs for houses, or other purposes. I have a cloth roof to my house painted with this new paint, and it is perfectly tight. The cost of such a roof is considerably less than that of ordinary roofs. The same materials, but with a less proportion of the oil, make an excellent water-tight putty."

PRINTING PRESSES.

"*Improvements in presses.*" Joseph Saxton, Washington, District of Columbia.

The patentee says,—"My invention and improvements consist, firstly, in the use of a flexible or elastic platen, instead of a rigid or inflexible plate of metal as a platen. Secondly, in the application of pressure to such flexible or elastic platen by means of a liquid, or aeriferous fluid; and thirdly, in the arrangement of machinery in printing presses, copying presses, and lithographic, and zincographic presses, for the purpose of applying such pressure to such flexible or elastic platen. The object and effect of using a flexible or elastic platen with the pressure by means of a liquid or aeriferous fluid is, that the platen is equally pressed or acted upon over its whole surface, and which may therefore be employed in any position, to press upwards, downwards, or sideways. The elastic platen is to be of the necessary size for the press in which it is to be used, as in the case of the ordinary platen, and is to be a thin plate of brass or other suitable metal, varying in thickness from that of a sheet of foolscap paper to about half an inch, according to the dimensions of the platen, and of the vacant spaces between the columns or pages of types or figures, technically in printing called 'the white.'"

SAFETY VALVES.

For "*improvements in the safety valve for preventing steam boilers from bursting or collapsing.*" Abraham Patterson, Rush, Pennsylvania.

The claim is for the employment of the apparatus termed the working column, in combination with the uplifting valve and float, as described, whereby the pressure of steam on the working column is added to the pressure on the safety or uplifting valve, for the purpose of opening it when the water descends below a given point, and which, at the proper height of the water, permits the free action of the uplifting valve. A claim is also made for the employment of a pendulum, so situated, or so suspended, that by the rocking, tilting, or careening of the boiler or boat upon which such pendulum shall be employed, the said pendulum shall so attach itself to, or so suspend itself upon a tackle, lever, or pivot, as thereby to apply its weight as a moving power to the opening of a safety valve or valves for steam boilers, as described.

RAILROAD TRUCKS.

For an "*improvement in railroad trucks.*" Fowler M. Ray, New York.

The patentee says the nature of his invention consists in substituting a single cross beam of timber, having end bearers of metal for the connecting bars of the axles, furnished with a single spring, and having a pedestal connecting the bearer, spring, and cross beam together at each side of the truck in such a manner as to give to the whole frame work or superstructure of the truck a yielding capacity, instead of the usual method of a stiff frame work, and short unyielding springs, two at each side, as heretofore most commonly constructed. By which yielding quality several desirable objects are effected.—1st, The capability of elevating either of the wheels of the truck to a considerable height without affecting the position of the remaining wheels upon the track, and by which obstructions are passed with greater safety. 2nd, It gives to each axle, independent of the other, a facility to vibrate laterally without changing their parallel position to each other, and by which, short curves are made easy. 3rd, Its yielding and elastic quality, rendering vertical and lateral concussions less severe than in the ordinary (rigid frame) truck.

IRON BOATS.

For "*improvements in the manufacture of boats and other vessels of sheet metal.* Joseph Francis, New York.

The invention consists in forming the sheets of metal with mouldings or beads in suitable places to take up the surplus metal, when the said plates are pressed into form, by means of projections on the die and corresponding depressions on the matrix, or concave mould, which gather up the metal and prevent wrinkles around between the upper and lower parts of the boat, so as to present a smooth surface, and also in forming a recess or bed for the gunwale, which holds it in place and prevents its getting knocked down. A flanch around the stem and stern posts, and along the line of keel, is also added, which takes up the surplus metal there, and forms the keel, and stem and stern posts.

REGISTER OF NEW PATENTS.

If additional information be required respecting any patent, it may be obtained at the office of this Journal.

ROLLING IRON BARS.

Thomas Howard, of the King and Queen Iron Works, Rotherhithe, iron manufacturer, for "*Improvements in rolling iron bars for suspension bridges and other purposes.*"—Granted October 6, 1845; Enrolled April 6, 1846.

Fig. 1. Fig. 3.

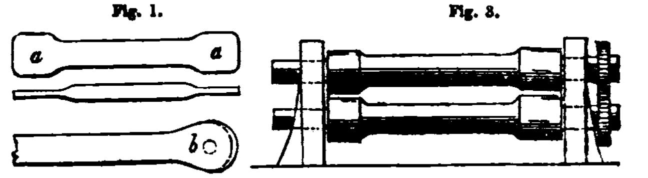
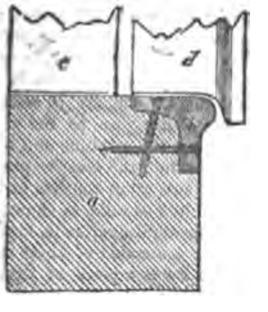


Fig. 2.

The improvements consist in a method of rolling wrought-iron bars with heads, or increased breadths thereon, in one entire piece, so as to avoid the uncertain and insecure process of welding such heads on to the bars, particularly when subjected to great strain or tension, as in suspension-bridges, and other works requiring similar bars. To effect this, the slab faggot or shingle from which the bar is to be produced, is heated in a furnace and passed through grooved or other rollers in the ordinary way, to form an elongated slab. This slab is then carried to what are termed heading rollers, having enlarged parts or collars upon them, between which the slab is passed edge first, or breadth ways, as often as is necessary, and which produces the form required on the slab *a*, fig. 1, while the intermediate part of the slab remains incompressed by the rollers, which are of less diameter where this latter part passes between them. The slab is then elongated by plain or finishing rollers of ordinary construction to the finished bar or length and thickness required, as shown at *b*, fig. 2. When the heads are intended to be of the same thickness as the other parts of the bar, they should come from the heading rollers sufficiently thick to receive some pressure by the finishing rollers, due allowance being made for the elongation, particularly when the bars are to be employed in suspension-bridges, in order to produce the grain or fibre of the iron in cross directions around the holes made in such heads, when completed by any ordinary means. A view of the heading rollers preferred is shown in fig. 3, and when the bars are large, it is recommended that these rollers have given to them a to and fro or reversing motion, by means of known machinery for such purposes, in order to expedite the rolling out of the heads in conjunction with the other operations, and to render a second heating of the slab unnecessary.

RAILWAY RAILS.

MOSES POOLE, of Lincoln's-inn, in the county of Middlesex, gentleman, for "*Improvements in rails for railways.*" (A communication.)—Granted October 6, 1845; Enrolled April 6, 1846.



The invention consists in so constructing rails for railways, that the wheels of the locomotive engines may run on wood, and the wheels of the railway carriages may run on metal, as shown in the annexed figure; *a* is a rail of wood armed with iron *b*, on the inner edge, *c* the wheel of a locomotive, and *d* the wheel of a carriage. The wheels of the locomotive engine being thus removed from off the metal rail will not be so liable to slip, particularly in damp weather, as has been heretofore the case, when the locomotive engines and railway carriages of the train all run on the same metal rails.

STEERING APPARATUS.

ROBERT CLARK, ship's painter, and ALEXANDER PIRNIE, ship's smith, both of Newburgh, Fifeshire, for "*Improvements in steering vessels.*"—Granted October 2, 1845; Enrolled April 2, 1846.

The improvements relate to an apparatus arranged as shown in the annexed engravings. Fig. 1 is a side view, and fig. 2 a plan. *a* is the steering

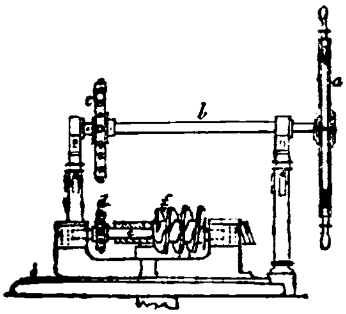


Fig. 1.

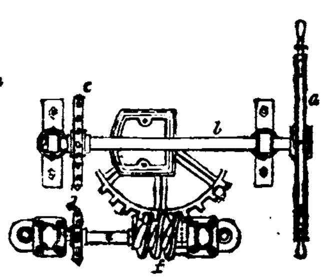


Fig. 2.

wheel fixed on one end of an axis *b*, on the other end is a chain wheel *c*, which by means of a chain transfers the motion to another small chain wheel *d*, fixed on an axis *e*, with an endless screw *f*, that takes into the section *i* fixed on the head of the rudder. The axis *e* turns on bearings, which are formed with cork or other elastic substance placed at the ends, so that any sudden movement of the axis endwise would be counteracted by the elastic packings. For the purpose of keeping the chain at all times tight, the standards carrying the bearings of the axis *b* are made to rise or fall.

GAS APPARATUS.

HENRY FRANCIS, of Wardour-street, London, civil engineer, for "*Improvements in the manufacture of Gas.*"—Granted Oct. 9, 1845; Enrolled April 9, 1846.

The apparatus consists of an ordinary retort, supported on a perforated tile fixed over a furnace; the openings in the tile allow the heat to pass freely to the retort, and at the same time form a complete support. This tile constitutes the first claim for improvements; the second claim consists in the mode of fastening the door to the retort; this door is made with inclined surfaces on the rim, and is ground to the mouth piece, so that when the door is pressed close by means of a key that turns it slightly round under fixed lugs, it will be gas tight. The gas, as it is made in the retort, ascends by a pipe in the front, and enters into a hydraulic main or vessel placed within a larger vessel fixed on the top of the brick-work over the retort; the larger or outer vessel receives the tar and ammoniacal liquor as it flows over from the inner compartment, and at the same time forms the tank for those materials. It is the combination of this apparatus in one vessel that constitutes the third improvement claimed. The gas passes from this inner vessel or hydraulic main by a pipe to a condenser, consisting of a coil of pipe or worm placed in the tank of the gasometer; by these means, only one vessel of water is used instead of two apparatus, as heretofore, for the condenser and gasometer; this constitutes the fourth claim. After the gas has passed through the worm condenser, it then passes into the purifying apparatus, consisting of a vessel divided into two compartments, and so arranged that wet and dry lime purifying can be adopted in the same vessel; this combination forms the fifth claim. From this vessel the gas passes back into the gasometer, and thence to the burners. To prevent the pressure of gas in the gasometer blowing up any part of the apparatus, there is a chain fixed to the inside of the top of the gasometer, and at the other end of the chain there is an inverted cap, which closes the orifice of a pipe standing up in the lower part of the gasometer; the upper part of the pipe just emerges above the water, so that when the cap is down it enters the water and forms a water valve; when the gasometer rises beyond a certain point, the cap is lifted off the pipe and allows the gas to escape down it and pass away to a distance. This valve forms the sixth claim.

CHIMNEY POTS.

GEORGE EWART, of New Road, Middlesex, zinc manufacturer and plumber, for "*certain improvements in the manufacture of chimney pots.*"—Granted November 2, 1845; Enrolled May 2, 1846.

The following is very nearly word for word of the specification of this invention, which is said to "consist in constructing chimney pots in such manner that each pot consists of a double tube, one portion sliding upon the other, and capable of being fixed to any desired height by the aid of thumb screws and nuts, or other convenient means." The pots may be constructed of zinc or other suitable material. The advantages arising from the application of these improved chimney pots are stated to be very great, inasmuch as it gives the power of increasing the draught of the chimney by increasing the height. The inventor claims the constructing of chimney pots to slide one upon another in the manner described.

SHIP BUILDING.

JAMES BOYDELL, Jun., of Oak Farm Works, near Dudley, iron master, for "*improvements in building ships and other vessels.*"—Granted November 17, 1845; Enrolled May 17, 1846.

The first part of this invention relates to a mode of building ships and other vessels with iron and wood, and secondly, to building vessels with iron. Fig. 1 shows a sectional plan of portion of the side of a vessel constructed according to the first part of this invention, in which *a a* represents the iron ribs of the vessel, on the inner edges of which is firmly fixed, by means of rivets, plates of iron *b b*; *c c* is the planking forming the sides of the vessel which is afterwards covered with copper in the ordinary manner

Fig. 1.

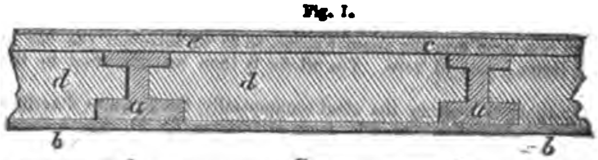


Fig. 2.

the space between the planking *c c*, and plates of iron *b b*, is filled up with timber marked with the letters *d d*, the grain of such pieces of timber or planks being in a direction fore and aft of the vessel. Fig. 2 shows a sectional plan of portion of the side of a vessel constructed according to the second part of this invention, in which *e* represents plates forming the sides of the vessel, *f* one of the ribs of the vessel having a groove throughout its entire length. The edges or ends of the plates are bent at right angles so as to enter the groove, and are secured therein by means of a wedge-formed bar *g*, the whole being firmly held together by means of keys *i*, which pass through holes in the rib, edges of the plate, and bar or wedge, as shown in dotted lines.

ATMOSPHERIC ENGINES.

JOSEPH RICHARD ATHA, of Walton, near Wakefield, of Yorkshire, engineer, for "*improvements in atmospheric engines.*"—Granted November 4, 1845; Enrolled May 4, 1846.

This invention consists in the application of wind power, as the first mover in the following manner. Four or more sails are to be attached to a shaft, which shaft is intended to give motion to two force pumps for the purpose of compressing atmospheric air into a large vessel or vessels, denominated receivers, which may be provided with a safety valve for preventing accident. From this vessel there is to be a pipe leading to a minor receiver fixed upon the carriage of a locomotive, the pipe to be capable of being connected and disconnected at pleasure, for the purpose of filling the minor receivers, and from which receivers the compressed air is to be admitted into the working cylinders of an ordinary locomotive instead of steam. The specification is not accompanied with any drawings to show how the above is to be carried into effect.

COMBINING STEEL AND IRON.

Charles Sanderson, of West-street, Sheffield, steel manufacturer, for "*improvements in combining steel and iron into bars for tyres for wheels, and for other purposes.*"—Granted Nov. 4, 1845; Enrolled May 4, 1845.

In carrying out this invention it is proposed to take iron which has been manufactured into a bloom in the usual way and of any required form, and pass the same through rollers suitably formed for making a cavity in the iron, which is afterwards to be filled up with liquid steel in the following manner. The bloom when in a hot state is to be passed between rollers or hammers, so as to form an indentation or hollow sufficiently large to contain the liquid steel intended to be incorporated with the iron as shown at fig. 1, in which *a* represents the bloom, having an hollow formed in one of its sides, which is to be covered over by a thin plate of iron, *b*, welded to the two edges of the bloom, so as to form a sort of tube, into which is to be poured the melted steel; the bloom is then worked up into the form required by the usual process of rolling or compressing, when the steel will be found to be united with the iron in the place required. In manufacturing rollers, piston-rods, mandrels, &c., the inventor takes a thin wrought-iron case or cylinder of about $\frac{1}{16}$ of an inch thick, the internal diameter being equal to the diameter of steel intended to be manufactured; within this cylinder is placed a rod of iron so as to form a sort of core, having an annular space between the iron and internal diameter of the case, equal to the thickness of steel intended to be cast or incorporated with the iron. The bar of iron being placed within the tube, and the same fixed in a vertical position, with the lower end closed; the melted steel is poured into the annular space, so as to surround the bar of iron which forms a sort of core. The whole is then manufactured in the usual way.

Fig. 1.

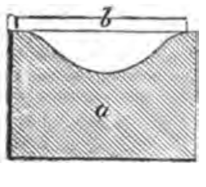


Fig. 2.

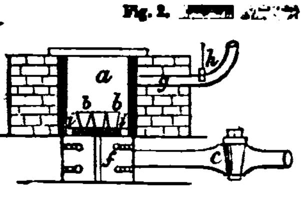
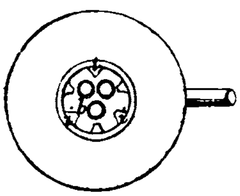


Fig. 3.



For the purpose of melting the steel economically, the inventor describes and claims as his invention a peculiar form of furnace (fig. 2), which shows a sectional elevation, fig. 3 being a plan; *a* represents the body of the furnace, built of fire brick; *b* are three crucibles for containing the steel to be melted; *c* is a blast pipe, provided with a stop-cock, and is made to enter the lower part of the furnace; *f* are doors which can be opened for the purpose of clearing out the furnace; *g* is the flue for carrying off the products of combustion, and is provided with a valve at *h*. The air from the blast pipe *c* enters a chamber, from which it passes through holes, *i*. into the furnace.

The inventor claims the mode of manufacturing steel as described, and also the application of a thin coating of iron, which protects the steel from injury during the subsequent process of manufacture.

PROPELLING VESSELS.

Stephen R. Parkhurst, of Liverpool, machinist, for "*a method of propelling vessels.*"—Granted Nov. 4, 1845; Enrolled May 4, 1846.

This invention consists simply in the application of seven, more or less, upright propellers on each side of the vessel. Fig. 1 shows one side of the vessel, with an end view of one of the propellers, and the position of the remainder, which are enclosed in an iron case having circular recesses somewhat larger in diameter than the diameter of the propeller, one of which is shown in elevation at fig. 2. In fig. 1 it will be seen that the blade or floats of the propellers are made to project a little beyond the case on each side of the vessel, and in order to protect them from injury by coming in contact with other vessels, a strong wooden beam, shown in dotted lines, is affixed to the casing so as to project a little beyond the floats of the propellers, which are to be driven by straps or other convenient means by the engines on board.

Fig. 1.

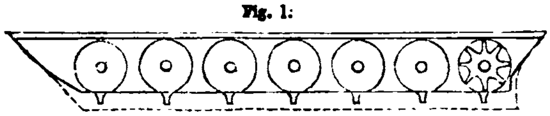
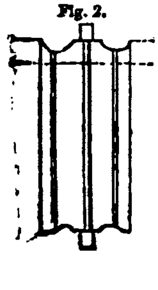


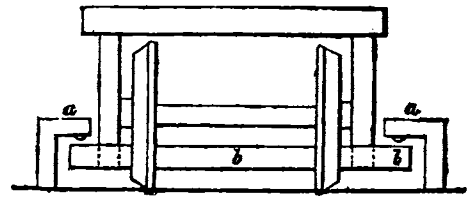
Fig. 2.



RAILWAY CARRIAGES.

Robert Miller Brandling, of Low Cosforth, Northumberland, Esq., for "*Improvements in railway and railway carriages for the security and convenience of the public.*"—Granted October 31, 1845; Enrolled April 30, 1846.

This invention is said in the first place to consist in a mode of keeping the wheels of the carriages upon the rails by the application of counteracting pressures, and by means that do not cause any shocks. Secondly, in constructing the machinery by means of which the railway trains are firmly attached to or released from the rope which draws them. Thirdly, in causing the trains to pass upon the surface without any obstruction to the usual traffic along the highways; and fourthly, in conveying the machine and rope below the surface, and also in a new mode of connecting the tractive power to the ropes used in railways. The first part of this invention consists in the application of an additional rail on each side of the line of rails, as shown in the accompanying sketch, in which *a a* represent the additional rails, having projecting ribs at right angles to the rails, on the underside of these rails there is fixed the segment or portion of a rail; *b b* is a piece of timber

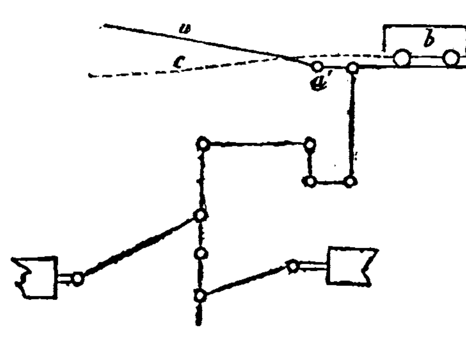


firmly attached to the framing of the carriage, the ends of which are made to pass underneath the projecting parts of the rails *a a*, preventing the carriage from getting off the line, "without producing any shock," which we very much question. The remaining portion of this invention appears to be a pack of nonsence, the drawings and description of which are very imperfect, indeed so much so that it is next to impossible to understand them.

ARRESTING RAILWAY CARRIAGES.

Dylrymple Crawford, of Birmingham, for "*certain improvements in the means of, or machinery for arresting the progress of railway carriages and trains.*"—Granted October 31, 1845; Enrolled April 31, 1846.

The first part of this invention relates to a mode of working the breaks, and consists in the application of a cylinder fixed in a horizontal position on the top of one of the carriages. This cylinder is provided with a piston and piston rod passing through a stuffing box in the usual manner at each end of the cylinder there is a stop-cock. To the piston rod is attached a chain, the opposite end of which passes round a pulley, fixed upon a short vertical shaft this shaft gives motion by means of two spur wheels to a vertical shaft, the lower end of which extends to the underside of the carriage framing, which by a peculiar arrangement of mechanism causes the breaks of the several carriages to be brought into action in the following manner. Suppose the piston to be at the bottom or further end of the cylinder, the stop-cock at that end is closed, and the cock at the opposite end, opened the piston, is there drawn by means of the chain and handle to the opposite end of the cylinder, the consequence is that a vacuum will be formed in the cylinder, and a pressure exerted on the piston in proportion to its area, both cocks are then closed, and the mechanism for withdrawing the piston is put in gear with the vertical shaft which gives motion to the breaks. It will therefore be seen that when it is required to put the breaks into action it is only necessary to open the stop-cock at the near end of the cylinder, when air will be admitted to the cylinder, the pressure of which upon the piston will be transmitted in the manner described to the breaks. For the purpose of opening the stop-cock a chain or rope is attached to the lever, and extends the whole length, of the train, so as to be under the control of the engine driver, or any of the guards upon the train. Another mode of working the breaks is shown in the annexed diagram. The top of the carriage there is a bent lever *a*, moving upon a fixed centre at *a*, *b'* is a heavy weight mounted upon wheels and supported by the lever *a a'*, *c* is a chain extending along the carriages of the



train to any convenient part, and is worked by means of a winch or handle, so that by drawing the weight along the lever *a a'* to the opposite end to that where the weight is shown, the end *a* of the lever *a a'* would be pressed down when the breaks *d d* will be brought into action by the arrangement of levers shown in the diagram which will be understood without further description. Another part of this invention consists in facing that part of the break which comes in contact with the wheel, with a casing or covering of wood, having a number of conical holes which are to be filled with chalk or a mixture of sand gravel, asphalt, or other attritive material. The inventor also proposes to attach to the back of the break a vessel containing a liquid for the purpose of keeping the break moist, and carrying off the heat.

JUNCTION OF THE BROAD AND NARROW GAUGES.

The following is a description of a plan patented by Messrs. Austin and Quick, for obviating the difficulties of diversity of gauges. It consists merely in the application of additional sets of wheels to each axle of the carriages, so that the same carriages may travel with equal facility both on the broad and narrow gauges, and pass from one to the other without stoppage or inconvenience of any kind. Fig. 1 is a section of a wagon, and fig. 2 of a carriage provided with the double sets of wheels. The locomotives of course would not require the proposed alteration, as each line would possess its own establishment of engines which would be changed at the break of gauge. On lines of uniform gauges a similar change of engines usually takes place every forty or fifty miles, without the least inconvenience to the passengers.

Fig. 1.

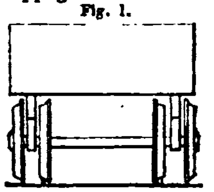
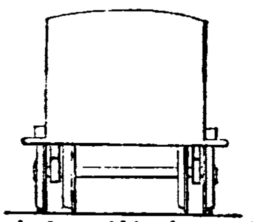
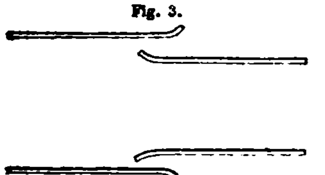


Fig. 2.



The carriages employed for the purpose would be of narrow gauge dimensions, the axles being lengthened sufficiently to receive the additional wheels. The axle bearings would be most conveniently situated between the wheels on either side, the grease or lubricating box being so placed as to be readily accessible between the spokes of the outer wheels. As the steps of the narrow gauge carriages now project invariably beyond the broad gauge dimensions; the additional wheels would involve no alteration whatever of bridges, tunnels, or even the station platforms of the narrow gauge lines. The only alteration required, throughout the works, for the uninterrupted passage of these carriages, would be an addition to the rails, at the crossings, to sidings, to allow the flanges of the wheels that are not travelling on the rails to pass through. It would be necessary at crossings to make *two* openings instead of one in each rail which is crossed, so that *both* sets of wheels might. At the junction of the gauges nothing more is requisite than that the sets of rails should overlap for a few feet. Fig. 3 represents the means of passing from gauge to the other.

Fig. 3.



The inventors calculate that the alteration of the crossings would at the utmost not exceed 25*l*. each, so that the cost on this head for a long line of railway would not amount to 1000*l*. In the case of a wheel breaking or a train getting off the rails, additional security would result from the extra wheels, as tending to preserve the carriages from upsetting and preventing their running entirely off the railway.

The proposed invention has certainly the merit of simplicity, and it is to be regretted that the Gauge Commissioners had not the opportunity of examining it. It is certainly much superior to the plan of shifting carriages from frames with narrow gauge wheels to frames with broad gauge wheels; an operation which must always produce delay besides lessening the security of the carriages. The telescopic axles are also liable to the objection of insecurity. The only danger from the new plan would arise from the accidental obstruction of the additional set of wheels by obstacles which did not lie across the rails. The additional dead weight would also be an objection of some importance. We can scarcely regard the invention as anything but a temporary expedient, but we are inclined to consider it much superior to those which have been hitherto proposed. The double wheels would only be required for those carriages which were intended for *through* traffic.

The Nelson Monument is once more in progress towards completion, the bricklayers are at work forming the foundations for the flights of steps and stone bases.

DAMPNESS IN BUILDINGS.

ITS CAUSES AND CONSEQUENCES, AND THE MEANS OF PREVENTING IT.

(Translated from the Magazin Pittoresque)[1]

Dampness penetrates into the lowest floor of buildings either from the soil itself or by means of the foundation walls; it frequently arises also from rain beating on the surface of the exterior walls.

The influence of the different causes of dampness varies according to the nature of the soil or climate, the aspect in which the houses are built, the materials employed in their construction, and the different modes of construction. To get rid of humidity in the lowest story, it is ordinarily supposed, that all that is required is to elevate the foundations within the building above the level of the external soil; but if no other precautions were employed, this super-elevation would not diminish the dampness which rises from the earth itself, and that from the walls would be very imperfectly remedied, supposing the buildings constructed without cellars.

Among the numerous bad consequences of dampness we must reckon as the principal its unhealthiness, and its destructive effect on almost every thing subjected to its action; it causes plaster to fall, ceilings and floors to decay, paint to peel off, paper to become rotten: furniture, pictures and books are rapidly injured by it, and even the materials of the walls themselves undergo a gradual alteration which diminishes their solidity.

A constant moisture is not however necessarily destructive to buildings built of stone: stones laid in the ground although constantly immersed in water, will remain uninjured; although this will not be the case where the stone is exposed by turns to dryness, moisture and frost.

It is a common expression that damp always rises: and it might thence be supposed that moisture, in order to affect a hygrometric body, must come from below it, whereas in reality moisture is also diffused downwards, horizontally, and in every other direction. Now the materials ordinarily employed in building, wood, brick, rubble, and stone of every kind, including even marble and granite, are more or less hygrometric; that is to say, if carefully weighed after having been immersed in water, are found to be heavier than they were when completely dry.[2] It is therefore clear that the opposition which the nature of the materials offers to the progress of moisture is much less than is commonly supposed.

Inefficacy of the ordinary remedies.

Till lately attention has been confined to the means of remedying dampness in buildings after they have been constructed; precautions have seldom been taken to prevent it in the first instance. Recourse is generally had to cements, plasters, and paint, applied to the interior surfaces of the walls so as to substitute by means of a body supposed to be impermeable, a dry surface for one more or less humid. Without desiring to analyse the qualities of the plasters usually employed, we do not hesitate to say that these various compositions, not only do not prevent, but do not even diminish, the real cause of the evil. The moisture which has penetrated through the walls is an agent of which the operation is continuous, and cannot be stopped. Its action cannot be diminished except by the action of air. The pretended *hydrofuge* cements merely disguise the evil for a certain period; they are even liable in many cases to the grave objection of diminishing the chances of absorption, and instead of helping to dry the building, tend to retain its moisture.

It is then the first cause of the evil which must be attacked. The only useful means are those which prevent the moisture from penetrating into the walls of the building, for when once it has entered them it is almost impossible to remove it.

Means of preventing dampness in the construction of buildings.

With respect to the dampness arising from the soil, the best means of preventing it is by interposing at a certain height some impermeable substance which will prevent the moisture passing beyond it. The only substances of this kind are lead, bituminous or resinous cements, and certain kinds of mortar.[3]

The interposition of a plate of lead or a layer of some bituminous substance in the thickness of the wall has been already tried with success, and is found to stop the progress of the moisture absorbed by the lower

1 This paper is an abstract of an Essay for which the first prize was awarded by the Society "D'Encouragement pour l'Industrie nationale." The author of the prize essay is M. Vandoyer, government architect.

2 From experiments made on the powers of absorption of different kinds of stone, it appears that a cubic metre of marble will hold 5¼ pints of water. A metre is 3 ft. 3 in.

3 The nature of the mortars best adapted to resist moisture is explained in M. Vicat's work. See the C. E. and A. Journal for February last.

portion of the wall. This plate or layer should be a little above the internal level of the foundations.

This method, however, though efficacious in resisting the dampness arising from the ground, does not prevent the effects which the humidity of the atmosphere produces on the exterior surface of the walls in their lower part. In ordinary buildings we may point out as an excellent preservative against atmospheric moisture, a revêtement of flag stones placed against the external face of the wall, and reaching to about a yard above the ground. If the foundations of the walls be of good limestone or grit-stone, this revêtement will not be necessary. It is well known that in the lower parts of walls to a certain height above the ground, the mortar of hydraulic lime should alone be used, and that when there are means of resting the foundations on an impermeable concrete, the best effects may be anticipated.

The precautions, then, to be taken against humidity in the walls are these—a foundation on hydraulic cement, the employment of hydraulic mortar in the lower parts of the building, the use of calcareous stones or revêtement built against the walls, and the interposition of an impermeable substance through the whole thickness of the walls between the exterior and interior levels of the soil.

ATMOSPHERIC RAILWAY.

Sir—I think your correspondent S. T. is labouring under a mistake when he speaks of monthly attacks on the atmospheric system. The comparison of theory and experiment shows that the development of the latent heat of air, during its sudden compression in the pump, causes a small and unimportant loss when the degree of rarefaction does not exceed the limits assigned by the patentees.

The loss by leakage depends on the degree of perfection in the machinery, and remains to be determined by experiment.

The regularity with which the Dalkey line has acted during the past year, as well as the high velocities attained on the Croydon line, are very satisfactory. The failings of the engines and pumps in the latter case have been frequent, but few will be inclined to doubt the possibility of surmounting this difficulty. After examining all the tables and writings that I can find respecting the practical working of a very defective example, I can see no good reason to doubt the capabilities of the system. One fair trial of the constancy of the system will be of more value than volumes written on the subject. In the mean time it is very desirable that the opponents of the system, should patiently await the result of the experiment that is now being made, for they may rest assured that the case will be decided on its own merits, and quite irrespectively of their assertions. In the mean time it will be remembered that the losses inherent in the system are very trifling.

A few years ago it was believed that the adhesion of the driving wheels of a locomotive to the rail was insufficient to enable it to draw its load and numerous walking machines were patented. A simple trial would have saved much time and money. It will be better to test the constancy of the atmospheric system rather than trust to doubts and surmises.

It has lately been asserted that the power of the locomotive is nearly double of the Croydon atmospheric. However, if the greatest evaporating power of any locomotive engine hitherto constructed be combined with any cylinder and driving wheels, in actual use, I think it will be found that at velocities of 60 to 70 miles per hour, the *efficient* power of locomotives falls considerably below that of the Croydon Atmospheric.

I remain, Sir,

Your obedient servant,

F. Bashforth.

Semper has been chosen architect of the new Picture Gallery at Dresden. At Berlin, the king has ordered the erection of a vast cathedral; the spires are to be 300 feet high. The new Campo Santo, which will be connected with the cathedral and palace by a collonade, will be a large open square, of which the sides will be 180 feet long. There will be a covered arcade or ambulatory all round the square; and the inner walls of this arcade will be covered with frescoes from the designs of Cornelius.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

May 11.—Mr. Tite, V.P., in the Chair.

Mr. Scoles, honorary secretary, read a letter from Mr. Myers, dated Rome, contradicting the reports which were current a short time ago, that the dome of St. Peter's was in danger. Some repairs had been made last summer, one or two of the string courses had been restored, and this had probably given rise to the assertion. A contradiction of the report appeared immediately after the statement was made. With reference to the fact that there had long been numerous cracks in the dome, the chairman reminded the meeting of an anecdote, respecting some figures erected in the cathedral, the architect, on being asked his opinion of them, said there was too much flutter in the drapery. "That;" replied the sculptor, "is caused by the wind through the cracks you have made in the dome."

A paper by M. De Lassaux, on a preparation of plaster of Paris, proposed to be used in England as an improvement on that now sold. In France, plaster is employed extensively for external work, and endures well; whereas that in England will not stand the weather. The buildings in the *Champs Elysées*, erected on lease for forty years, are mainly constructed of plaster. The Circus there, a model in its way, is chiefly of iron and plaster. The English plaster-stone might be called a sulphate of lime; and he considered it was the presence of a small quantity of sulphuric acid in the plaster which prevented its endurance. The plaster, for which he had established a depôt in England, might be used externally, as in France; and, moreover, was very moderate in cost, being 30*s.* per ton. As a guide, the paper stated, twenty-six pounds of the plaster, costing 4½d., would cover one yard of wall; and thirty-two pounds, the cost of which would be 5½d., a yard of ceiling.

Mr. Bellamy observed that the price at which it was stated in the foregoing paper that the plaster could be supplied, was most materially lower than that of English plaster. He wished, however, to know whether the price mentioned included the import duty. The present cost of plaster in England was 3*l.* 10*s.* per ton for the coarse, and 4*l.* 5*s.* for the fine; so that the difference between this and the plaster introduced by M. de Lassaux was very great.

M. De Lassaux replied, in French, that there was no duty on plaster imported into England. He alluded also to the valuable property of this plaster when used as a coating to iron, of preventing oxidation. The plaster was thoroughly dried in eight days.

Mr. Tite remarked on the very extensive use of plaster for external decoration in Paris, which was a principal cause of the difference between the appearance of the streets of that city and those of London. A great difficulty in introducing cement into general use here was its shrinking in the drying, and this difficulty was especially felt when the material was employed for "pointing," or filling crevices. Almost every kind of cement, except plaster of Paris, diminished in bulk in setting, and consequently was apt to fall out when used in pointing. Plaster of Paris, however, expanded in setting: it probably contained a portion of carbonate of iron as well as sulphate of iron. A remarkable illustration of this property of expansion was afforded by the method in which party-walls were usually built in Paris. They were never connected with the external walls, as in this country, but were separated from them by a considerable interval. The reason of this was, that the party-walls being built of rubble, it was necessary to make considerable allowance for their expansion in drying. When used for external mouldings, it was usual in Paris to protect the upper surface of the plaster, which was most exposed to the weather, with thin plates of zinc.

Mr. Poynter thought that the great difference between the climates of London and Paris must have a great effect on the durability of these mouldings when used externally. Wooden blinds which, when exposed to the air, would not last more than a few years in London, would in Paris remain sound almost as long as the houses themselves. Canvass blinds, in England, generally perished in two or three years. He considered that this rapid decay was owing not so much to the actual quantity of rain which fell in a year, as to the general humidity of the atmosphere. This was particularly observable in the vine, a plant which, it was well known, endured a degree of cold far more intense than it was ever subjected to in England, and yet never flourished in this climate on account of its constant moisture.

Mr. Bellamy remarked that he had observed, in Nottinghamshire, two instances of houses being thrown down from space not having been left for the expansion of the party-walls when built with plaster.

Mr. Tite did not think the humidity of the air here was a sufficient cause for the explanation of the rapid decay of plaster. The climates of some parts of Switzerland and Bavaria were fully as humid as our own, and yet these effects were not observable there. At Freiburg, for instance, black tin was very much used externally without decaying or becoming tarnished. The angles of the spires of churches were frequently covered with sheets of tin, which, when the sun shone on it, looked as bright as silver. In the same way, tin was used for the heads of water pipes and other purposes with equally good effect. In Canada, also, the same thing was observable, and it could hardly be disputed that the climate of many parts both of Canada and Switzerland was quite as damp as that of London. He thought there must be another agent at work to produce the destructive effect alluded to; he was, however, unable to indicate the true cause. It was well known that the air here contained a certain quantity of sulphuric acid, arising from the combustion of coal; the quantity of the acid was, however, so small, that it was difficult to detect it by chemical analysis. He had enquired of several excellent chemists, but they were unable to state what effect the sulphuric acid in the atmosphere had upon building materials.

Mr. Godwin alluded to the necessity of seeing that work of every kind was perfectly dry before the cement was laid on. He had recently had occasion to use Jardan's cement, and had, as he thought, used sufficient precaution in waiting till the work was dry. Owing, however, to the slight quantity of moisture which it retained, the plaster all fell off.

Mr. Tite observed, that all cements of this class, beginning with mastic, were, chemically speaking, nothing more than very coarse paints, mixed up with oil or grease. The disadvantages attending this class of compositions was that the sun and wind dissipated the fatty matter or oil with which they were combined, and the cement soon decayed. The Portland-stone cement, which was, in fact, the hydraulic cement of the French, was an excellent material, and was in almost universal use in France. It was absolutely necessary that this material should be mixed with a certain proportion of clay: it was also of the greatest importance that after it had once been "gauged," it should never be disturbed or touched till it was thoroughly hardened. Unless this precaution were strictly observed, the permanence of the work could never be ensured. It was also a good rule that were patent cements were used, the patentees should be required to use it with their own workmen, and not with strangers, who were ignorant of its nature.

Mr. Poynter referred to the use which Mr. Nash had made of the oily cements in his own house in Regent-street, as a proof of the disadvantages to which those compositions were liable. It might be supposed that the cement being applied to the architect's own house, the work would be done in the best manner possible. It was found, however, that the oil soon fried out, and the surface became discoloured with the well-known stains resembling the lines in maps.

Mr. Tite remarked that the Portland-stone cement was, in fact, an artificial imitation of the nodules of lime, from which Roman cement is prepared. The nodules are found in great abundance on the coast near Harwich. They fall from the cliffs, in which they are imbedded, on to the beach, and are there picked up. They are compact masses of carbonate of lime containing a small quantity of iron, to which latter substance they owe their dark brown colour. The *chaux hydraulique* was precisely the same substance, without the colour derived from the iron. He thought, however, that the iron added materially to the strength of the cement when hardened, and that for this reason the Roman cement would never be equalled in strength by any artificial composition. Atkinson's cement was made of nodules in which the iron was not present; the advantage of this and the hydraulic lime was, that they naturally possessed a good colour and did not require painting.

SOCIETY OF ARTS, LONDON.

April 29.—W. F. Cooke, Esq., V.P., in the Chair.

The first communication was "*On Mr. Godson's Patent Furnace for consuming smoke and economising fuel.*" By W. Spence, Esq. The general features of the furnace and the parts of which it is composed may be thus described:—A box with a moveable bottom, or feed-plate for the fuel, and fitting its internal surface, is substituted for the ordinary bars in the middle of the furnace, and is capable of being raised or lowered within the box or chamber, and which is made to occupy a position in the ash-pit below the furnace. The fuel is fed on the plate while in its lowered position; and when raised it is introduced into the centre of the fire, by which means the smoke evolved from the fresh fuel is consumed. In order, however, to render such a mode of supplying fuel available for its purpose, it is necessary that at the time when the feed-plate in the centre of the furnace is to be lowered to receive its charge, the portion of burning fuel resting thereon should be supported: for this purpose two plates of metal are made to enter the furnace, one on each side, and meet in the centre. Again, it is requisite for the due promotion of the draft into the furnace, that inasmuch as the centre support of the fuel consists of a dead plate, that plate should be kept a little below the fire bars, and that a series of oblique bars should be formed, and extend from the ordinary fire bars to the plate. A model and diagrams of the invention were exhibited, and a lengthened discussion took place as to its merits.

The second communication was "*On a Machine to Register the Velocity of Railway Trains when in motion,*" by M. Ricardo, Esq. The machine consists of two parts: one receives motion from the carriage, the other by clock-work. They are arranged in the following manner:—an excentric is placed on the axle of the carriage, and gives motion, by means of a connecting rod, to a lever attached to the machine, which lever acts upon a ratchet wheel, and is so arranged that each revolution of the wheel of the carriage advances the ratchet one tooth. An endless screw is turned on the spindle of the ratchet wheel, and gives motion to a small toothed-wheel below, and on the spindle of which is fixed what may be termed a lateral excentric (as one part projects more than the other on the side of the wheel). Against this the short end of a horizontal lever is pressed, by means of a spring. As the excentric revolves from the projecting to the lower part, it moves the lever, and with it a pencil fixed at its other end, in one direction, till it reaches the lowest point; when, by a spring pressing upon it, it takes the opposite direction, till it reaches the highest point, when it returns again. The wheels are so arranged, that the excentric makes one revolution in each mile that a train travels. The clock-work is used to turn a drum, upon which a ruled paper is wound. When the train is stopping at a station, the pencil is stationary, and marks only a straight line; but when in motion, diagonal lines are drawn by the action of the lever as described. The extreme distance between the two points of the diagonal lines determines the velocity at which the train has been travelling. Thus, the train is made, by this apparatus, to keep a perfect register of the work done, which would at all times indicate the neglect of either the engineer or conductor.

May 6.—Thomas Webster, Esq., M.A., V.P., in the Chair.

The following communications were read:—

1. *On an Improved Poppet Head for Turners*, by W. Everett, Esq. The first attempt at improving the poppet head (observes Mr. Everett) was to take off the point and insert a screw carrying a spindle and wheel fitted up as a drill, to be driven by the overhead motion, and this he found to answer very well when the hole to be drilled could be brought in a line with the drill. Having done this he still anticipated that he could make this part of the lathe more useful, in fact a substitute in a great measure for the slide rest. The following motions have therefore been given to the point. 1st. An upward and downward motion so that it can be applied to all lathes. 2d. A circular motion which enables it to be applied at any required angle; and 3rd, a motion directly across the mandril, and there is no motion but what is strictly mechanical, as each has a scale to guide the workman in its use. Several gentlemen present examined the instrument and its arrangements and considered it likely to prove a valuable addition to the ordinary lathe.

2. *On the Ventilation of Buildings.* By Mr. A. J. Green.—The paper commenced with an account of the various plans which the author adopted for the purpose of ventilating the sick ward and other rooms of the Sudbury Union Workhouse, and it then proceeded to point out the way in which he would propose that all large buildings about to be erected should be built. Where a double chimney is to be erected, he proposes that two air flues should be carried up in the stack as near the centre as they can be got. If the chimneys are not in the centre of the side or end of the room, the flues should be carried so as bring them as nearly into that position as possible. The flues need not be more than 14 inches by 6 or 7 inches, or 9 inches by 9 inches, and should be commenced from the first floor and continued through every successive story to the top of the chimney, in the same way as the flues for the smoke. One flue of the above size would be sufficient to ventilate four or five stories, if each room required it—valves would require to be fixed in the wall or ceiling in connection with the flue. This system of ventilation, he considers, would be very applicable to smoking rooms, tap rooms, eating houses, or any buildings where a large number of persons assemble.

3. *On the Concentrated Gravy of Meat.* By Mr. Warriner.—This article is manufactured at Sydney, New South Wales, from the carcases of oxen and sheep, which are bred there for the sake of their tallow, wool, hides and bones. The value of oxen in Australia is from 15*s.* to 20*s.*, and of sheep 1*s.* 6*d.* to 2*s.* 6*d.* each. During the last year the leg bones of upwards of 109,000 oxen were sent over to this country, the greater part of the flesh of the animals having been thrown away. The object of the present manufacture is to render down the lean of the carcase into a solid portable soup, by stewing it down in its own gravy, without water, in double pans; by reducing it in this way the water in the lower pan prevents the fire passing through, and giving to the soup the burnt flavour which it has always hitherto had. When manufactured it is sold in cakes of various sizes, at the rate of 2*s.* per lb. One pound of the soup is said to be equal to 24 lb. of the best gravy beef.

CHEMICAL SOCIETY.

April 20.—A paper was read by Messrs. Joule and Playfair, "On the maximum density of water." In this the authors contended that the point of maximum density is the proper standard at which water should be taken as unity for the purpose of comparing specific gravities. There are two methods for determining the point of maximum density of water; one of these being the comparison of water in its expansion with that of some other substance the expansion of which had been already determined; the other virtually consists in weighing water in water, and was pursued by Hope in his original researches on this point. The authors adopted the latter method as the one most likely to yield correct results, but altered the method of experimenting, and the nature of the apparatus employed. Their apparatus consisted of two vessels connected at the bottom by a pipe with a cock, above by an open canal. One of these vessels was made to contain water at a temperature decidedly below that of the maximum density, the other being above that temperature. On opening the stopcock, a current took place from the colder vessel to the hotter, until a certain time, when the current became reversed. The rapidity and direction of the current was determined by hollow glass beads. The experiment was tried under varying conditions; and, as a mean of several series of experiments, the authors fixed 39·101° Fahr. as the point of maximum density, stating that they believed this to be within $\frac{1}{100}$th of a degree of the truth; at all events, that it could not be $\frac{1}{20}$th of a degree in error.

AUST SUSPENSION BRIDGE.

SIR—I observe in your number of last month a letter signed "Francis Giles," relating to the Aust Suspension Bridge, to which is appended a diagram and some calculations respecting it. On these latter it is not my intention at present to offer any remarks, beyond expressing my satisfaction that Mr. Giles thus publicly makes known an opinion, which I before knew he entertained, of the perfect practicability of erecting a bridge upon the suspension principle, suitable for railway purposes across the river Severn, between Beachley and the Aust Cliff. It is the general inference from Mr. Giles's letter to which I wish to direct attention: as I feel, though it may not be designedly intended, it is calculated to incline those who may peruse it to the impression, that the idea of erecting a bridge at this locality originated with him.

It will be found upon reference to the evidence given before the same Committee upon the South Wales Bill in the Session of 1845, to which Mr. Giles refers, that I had previously expressed a decided opinion upon this important subject; and that prior to this, James Walker, Esq., had made the following mention of my views in his Report to the Lords Commissioners of the Admiralty as to the crossing the River Severn as proposed by the South Wales Railway Company, viz., "Mr. Fulljames, county surveyor of Gloucester, considers that a Suspension Bridge, 120 feet above high water mark, at the Old Ferry, or Aust Passage, is practicable. He thinks the piers might be placed on rocks which are bare at low water; but being particularly dangerous at some states of the tides, would have their situations defined by the piers." These views were based upon the results of observations and soundings taken by me at the Old Passage in the year 1838. Whilst engaged upon this, I found that in the year 1825, Mr. Telford, the late celebrated engineer, was consulted upon the improvement of the communication across the River Severn at the Old or Aust Passage, and the New Passage three miles to the southward; and though his attention at that time was specially directed to ascertaining and reporting upon the best situations and mode of constructing landing piers for the convenience of the steam boats, the peculiar inducements and natural facilities for the erection of a suspension bridge at the Old Passage did not escape his acute and comprehensive observation; and though foreign to the subject on which he was called upon to report, so strong was his conviction of its desirableness, that he gave a most decided opinion in favour of a suspension bridge at the Aust; particularly adverting (as the reasons for so doing) to the great height of the banks at the Old Passage, to the fact of the bed of the river consisting wholly of solid rock, and to the circumstance that suitable materials for the work could be procured within a reasonable distance.

During the summer of last year I have been professionally employed by the Bristol and Liverpool Junction Railway Company to report upon this site, and the kind of bridge best adapted for it, both as regards their proposed railway and the navigation of the river, and under their directions have prepared designs for this bridge, on one of which, the opinion expressed by James Walker, Esq. (to whom it was referred by the Admiralty to report as regarded the interests of the navigation), has induced the Lords Commissioners of that Board to consent to the principle of the bridge proposed. The reports and plans have been published, together with the design approved by the Admiralty; of these I enclose you copies, by which you will perceive that Mr. Giles is not the only party whose attention has been directed to this truly national and most important subject.

I beg to remain,
Yours obediently,

Gloucester, May 25th, 1846. THOMAS FULLJAMES.

FOREIGN PUBLIC WORKS.

Recent Prizes proposed by the French Institute (accessible to all nations). —Prize of *Mechanics*, founded by M. Montyon, gold medal of 500 francs, for the discovery or perfecting of instruments useful in the mechanical arts, sciences, or agriculture: term of competition, April 1, 1847.—Prize of *Hygiene*, for the discovery of a remedy for making any art or trade less insalubrious: term, the same. The Prize of *Mechanics* of last year, as well as the great one of 6000 francs on the application of *Steam*, has been adjourned, and that on the insalubrious arts decreed to M. Chausserat.

Expulsion of Foul Air from Mines.—An engineer (M. Halaud) has forwarded to the Academy of Sciences at Paris, a very interesting memoir on the expulsion of foul air from mines, pits, cellars, and similar places. It consists in the pumping of *steam* into places thus contaminated, which, if the foul air consists of hydrogen gas, acts merely as a forcible expeller; but if it be carbonic acid gas, the steam will also absorb that substance. As most places where deep excavations are now made, are near steam engines, the pumping of steam into mines, &c., becomes the easier. It is to be done through elastic tubes covered with india-rubber. The inventor states, that in a deep pit, where the work had been suspended by necessity for several days, the emission of steam purified it to that extent, that the workmen were able to go down as usual.

Public Works in France.—A report of M. Oger has lately been distributed at the Chamber of the French Deputies, to be laid before the commission appointed to examine the bill for the completion of several public edifices. The first of these structures is the Palace of the Archives of the realm. The commission, in lamenting the mistakes and disappointments to which the erection of this edifice has hitherto given rise, proposes a grant of 606,000 francs, on condition that the stuccoes, gilding, and paintings of the original project should be replaced by *cases* more adapted to a depôt of archives. It further alludes to the dangers of the steam engine of the Royal printing offices being so near this invaluable collection of national records.—The Conservatory of Arts and Trades (*C. des arts et métiers*) figures for a sum of 1,441,000 francs, which is to employed in the restoration of such portions of the edifice, which have been completed, in augmenting the number of its halls of exhibition, and opening a principal entrance in the Rue Saint Martin by the purchase and demolition of two houses.—250,000 francs is to be expended on works of the Royal Veterinary School, at Alfort; 650,000 francs at that of Lyons; 89,000 francs at the School of Arts and Trades of Châlons*; 180,000 at the building of the Royal Observatory of Paris.—180,000 francs are proposed for the Palace of the Chamber of Deputies. The ancient chapel, says the report, is in the worst possible state, and although used but very rarely, its restoration is desirable as a matter of public decorum.—The offices of the secretary of state for agriculture and commerce require a sum of 43,000 francs; and, finally, 45,000 francs are to be expended in the demolition of the belfry of the north tower of the church of St. Denis, which menaces ruin.

Archæological Society of Rome.—At the anniversary lately held, Dr. Braun stated the present prospects of the great publication undertaken by the Association—the *Monumenti inediti*. Cavaliere Canina spoke of the discovery of the eleventh mile-stone of the Via Laurentina, which has thrown much light on the position of the laurentine villa of Pliny and the city of Laurentium. The elucidation of some ancient inscriptions of Cora was also alluded to.

Munich.—Independent of the great progress which *inventive* art is constantly making here, the multiplying of objects of art is equally advancing. The great engraving of Professor Amsler, after the picture of Overbeck—"Triumph of Religion in Arts,"—which was begun four years ago, is near its completion. Kaulbach's great picture of the destruction of Jerusalem, has also been begun by M. Charles Waagen.

The Architectural Drawings in the late Art Exhibition of the Louvre—are not much praised, as they consist mostly of restorations, of good appearance—at least on paper—of ancient, mediæval, and renaissance structures. The only specimen of interest bearing on a practical subject is the plan for uniting the Louvre and Tuilleries by M. Badenier, of which, the artist had already exhibited some studies in 1844 and 1845. It is, however, not probable that amidst the many plans of a really *practical* nature, the French government will embark an immense sum in a plan, after all, but ornamental.

French Architectural Exploration of the Island of Cyprus.—M. Mas Latrie, commissioned by the Secretary of Public Instruction for the above undertaking, has addressed the following remarks to His Excellency:—"Everywhere in this island I have found traces of the former sway of France. There is scarcely a town or village which does not contain either a church, or abbey, or castle of the French occupants in the Middle Ages. I have made careful tracings of the slabs best preserved of the sepulchral monuments of her once great families, the Ibelins, Brunswick, &c. The Gothic edifices constructed by the French in Cyprus can be divided into two classes—military, and religious. I have especially studied in each of those the modifications which *ogival* architecture has undergone in Cyprus, compared with the Gothic in France at the same period. I have ascertained the position of the principal castles and monasteries, and laid down by the compass many points and localities important to mediæval geography. I have also somewhat swerved into the domains of Classic antiquity, and have discovered several inedited Greek inscriptions, and, by the means of excavations made at Dali, brought to light several fragments of statuary, &c. I have ascertained the real position of ancient Larnaca and Citium, the birthplace of Zeno the Stoic. In excavating a place near the high city of Larnaca, we have found a basalt slab of 7 feet high, 2¼ feet broad, and 1 foot thick. It is covered with cuniform inscriptions, and the figure of a king or priest, bearing the garment of those figures discovered by Mr. Botta in Mesopotamia. I think this to be a tomb, and one of the rarest monuments of the dominion of the Assyrians in Cyprus." M. Mas Latrie proposes, in fine, that some of the specimens should be deposited in the Museum of National Antiquity at Cluny.

Model Railway in France.—It seems that Arles, the place where Roman structures 1800 years old exist in such perfect preservation, is prompting French engineers to similar exertions. The following is a short extract of the projects for the present buildings.—The viaduct of the railway of the Durance River, will have a length of 493 mètres between the abutments, besides 20 mètres of abutment at each side, which will give it an absolute extension of 533 mètres. Its height is to be 9 30 mètres, computed from low-water mark to the level of the rails; its breadth 8 mètres between the parapets. It is to be supported by twenty piers of 3,50 mètres thickness, combined together by twenty-one elliptic arches of 20 mètres opening. The elegance of the piers, the gracious opening of the arches, and the imposing mass of the Viaduct, will make it one of the finest structures of

* Our readers will perceive that all these public institutions are maintained by public money.

the whole line. After this immense art-structure, the thing next worthy of admiration is the cutting of the rock of la Roque—an immense mass of stone, which was to be cut through from top to bottom to the extent of 125 mètres by 25, which yielded a mass of 42,000 cube mètres of débris of rock. Especially also is to be noticed the nicety of the nineteen cottages of the guards of the line, between Arles and the Durance. To each a little garden has been annexed, to employ profitably the leisure of the men and families. Follows then, the monumental viaduct of the Rhone, which will connect, by the way of Tarrascon, the Avignon line with that of Bordeaux to Cette. This gigantic structure is already begun. It is only 370 mètres from the suspension bridge of Beaucaire; thus two of the finest and hugest modern structures will be erected at a short distance from each other. The activity on the railways in the south of France is now so great, that in the arrondissement of Aix alone, 1390 workmen are employed.

New Hospital at Constantinople.—The East, which, during the crusades first established those—unknown to the ancients—institutions of public benevolence, is it seems, reverting again to that praiseworthy practice. A new hospital is to be erected, by the voluntary subscription of the Protestant inhabitants of the Turkish metropolis.

New Excavations in Assyria.—From the head quarters of M. Laynard, at Nimrud, at the embouchure of the Zab in the Tigris, the following is reported. The mound at which M. L. is digging is an artificial one, like that of Chorsabad, and the ruins are covered by soil; but the stratum at Nimrud is less than that of Chorsabad, so much so, that many of the basso-relievos are broken off at the upper part. The vestments of the figures are different from those discovered by Botta; but there is no doubt that the ruins are also of Assyrian origin. There are more basso-relievos of a mythological character at Nimrud, but the structure of both the palaces is the same. Here also are door-ways of colossal winged bulls, lions with human heads and arms, in which they carry flowers, &c. The number of inscriptions is very considerable.

Campo Santo of Berlin.—The celebrated painter, Baron Cornelius, is expected shortly in the Prussian capital, on his return from Rome, where he went to compose the cartoons of the Frescoes, which have to adorn the walls of the great cemetery, which is to be erected in the neighbourhood of Berlin, similar to those of Munich and Pisa.

Safety Harbours in France.—The Lower House of the French Legislation has, of late, received the Report of M. Felix Réal on the above subject. The Commission, convinced that every facility afforded to commerce will react on all other branches of public utility, has sanctioned this Report, with rescinding only the execution of the maritime canal between the harbours of Bouc and the étang de Berne. The Commission has moreover recommended that Government should employ some professional persons to study the means, by which the mouth of rivers can be made accessible to ships during low water tide.

Directorship of the Dresden Picture Gallery.—M. Julius Schnorr Carolsfeld, of Munich, has obtained the above situation, with which also that of a professor at the Academy of Painting is combined. The King of Bavaria has given, but reluctantly, his consent; the more so, as a number of Munich artists had addressed his majesty for the sake of retaining this great artist amongst them. As M. Schnorr has yet to paint several frescoes of the Niebelungen Song in the new royal palace, he will not leave the Bavarian capital until the end of summer, and will return every season until these great mural pictures are completed, which will occupy him many years to come.

The Iron Trade in Austria and the Zollverein.—All the iron to be used for the railroads of Austria must be of *home* consumption, foreign metal being excluded by a heavy duty. This has advanced their forges and furnaces to a great extent. But it is to be seen, whether this exclusive and *protectionist* principle will work well in the long run.

The Bronze Statue of Charles John, King of Sweden—has just been cast at the foundry of Munich. According to all appearance, it will be a superior work of art, and ready for being conveyed in a few months to its destination at Norrköping, in Sweden.

The Monumental Fountain of the Place of St. Sulpice, at Paris—will be completed this season. For months past, the square has been encumbered by immense blocks of stone, which have been cut for forming the immense basin of this monument.

M. Jules de Saly, architect of the Chamber of Commons of Paris, has been elected honarory and free member of the Imperial Academy of Fine Arts at St. Petersburg.

Monument to the Duke of Belluno.—An enormous block of white marble, from the quarries of Laveline (Vosges), of the weight of 10,000 kilogrammes, has been of late conveyed to Epinal. It is to form the basement of the statue of the duke, which is to be erected to his memory at Lamarche, the little village where this distinguished warrior first saw the light.

Trying of Railway Bridges.—It appears that these structures are not made use of for public traffic in France, until their solidity has been tried, by official persons. Thus the elegant bridge over the Seine, at Courcelles, near Paris, on the Rouen line, has undergone that ordeal, and been found completely safe.

Organization of Public Works in Algeria.—The French Government has created an especial *direction of Public works* for Africa, and a member of the Council of State is placed at its head. Even the name of the supreme office of public works is to be changed, which will henceforth be called Direction of the Interior and of Colonization. Chief Engineers have been nominated for each province. The hydraulic works of the harbour of Algiers and the service of mines in that province, are under the charge of especial government engineers.

Railroad through the Continent of South America.—Means have been discussed at Rio de Janeiro, to connect, in the first instance, Liverpool and Para by the means of steamboats, from which latter place minor crafts have to ascend the Amazon river so far as Bolivia. A railroad has to traverse the latter country and to extend as far as Arica, on the shores of the South Sea. The government of Bolivia has already given its assent to that plan, and a similar step is expected to be taken by that of the Brazils.

New Structures at Berlin.—Much scope to the industrial exertions of the inhabitants of that capital will be afforded shortly by the construction of the new navigation-canal, and the buildings over that large area now called *Köpenicker* Fields. The latest news from Berlin, state that an especial commission for carrying these plans into execution has been appointed by the king. The plans proposed exhibit a thorough ornamental, spacious, and sterling *ensemble;* and amongst the public buildings, new parochial churches, both Protestant and Catholic, occupy the first place. It is generally hoped that they will approach the grandeur of the new religious structures at Munich.

NOTES OF THE MONTH.

The first stone of a new wing of the University College, in Gower-street, has been laid. The ceremony was performed by Lord Brougham, the president of the council.

A new story has recently been added to the Treasury and adjacent Government offices, under the superintendence of Mr. Barry. The show sides fronting Downing-street and Parliament-street are nearly completed; the columns are hoisted to their former position on the first floor.

An equestrian statue of the Duke of Wellington is about to be put on the top of the triumphal arch in Piccadilly. A huge arch supporting nothing is bad enough; but the proposed addition makes it absolutely *too* ridiculous. Even members of Parliament have been able to dedect the absurdity, and have complained of it in the House of Commons. The view of the statue will be the exact reverse of a bird's eye view: an admiring public will have excellent opportunities of contemplating the horse's belly and girth, and the soles of the hero's shoes.

The evidence before the Royal Gauge Commissioners and their report have been referred to the Board of Trade.

The Archœological Congress of France will commence on the 1st of June. The proceedings of the British Association for the advancement of science will commence at Southampton on the 10th of September.

Masses of iron and nickel, having all the appearance of aerolites or falling meteoric stones, have been discovered in Siberia, at a depth of 10 metres below the surface of the earth. From the fact, however, that no meteoric stones are found in the secondary and tertiary formations, it would seem to follow that the phenomena of falling stones never took place till the earth assumed its present form.

The restoration of the western part of Ely Cathedral progresses. Fears are, however, expressed as to the stability of the octagon tower. The lanthern is of Perpendicular architecture, and a subsequent addition to the octagon, which is of much earlier date, and does not seem to have been built of sufficient strength for sustaining the load now resting on it.

The Cathedral of Spires is to be adorned with frescoes at the cost of the King of Bavaria.

A great black stove has been placed in the choir of Bristol cathedral, with a black chimney mounting straight up to the vaulted roof, which is pierced to make a passage for the smoke.

LIST OF NEW PATENTS.

(From Messrs. Robertson's List.)

GRANTED IN ENGLAND FROM APRIL 28, 1846, TO MAY 26, 1846.

Six Months allowed for Enrolment, unless otherwise expressed.

William Edward Newton, of Chancery-lane, civil engineer, for "certain Improvements in clocks or time keepers." (Being a communication.)—Sealed April 28.

Samuel Pickford, of Stockport, glass dealer, for "certain Improved apparatus applicable to casks or vessels for preserving ale and other fermented liquors, and also for raising or forcing the same for draught."—April 28.

Isaac Henry Robert Mott, of 76, Strand, for "certain Improvements in musical instruments, whereby they are rendered much more durable, much more capable of resisting the injurious and destructive effects of the atmosphere, (especially of extreme climates,) and whereby the quality of their tone is greatly improved and remains good for a much longer period."—April 28.

William Higgs, of Westminster, chemist, for "the means of collecting the contents of sewers and drains in cities, towns, and villages, and for treating chemically the same, and applying such contents when so treated to agricultural and other useful purposes."—April 28.

Anthony Nathan de Rothschild, of London, merchant, for "Improvements in heating apparatus and buildings." (Being a communication.)—April 28.

William Mather, of Salford, near Manchester, and Colin Mather, of the same place, millwrights and engineers, for "Improvements in metallic pistons."—April 28.

Charles de Bergue, of Arthur-street west, London, engineer, for "Improvements in atmospheric railways."—April 28.

James Timmins Chance, Handsworth, Stafford, glass manufacturer, and Henry Badger, of West Bromwich, glass stainer, for "Improvements in the manufacture of glass."—April 28.

Joseph Douglas, of Newcastle-upon-Tyne, rope-maker, for "Improvements in the manufacture of yarn, twine, and cordage."—April 30.

Joseph Touché, mechanist, of Rue St. Antoine, Paris, for "Improvements in lamps."—April 30.

Edward Augustin King, of Warwick-street, Charing Cross, Middlesex, gentleman, for "Improvements in the production of magnetic electricity." (Being a communication.)—April 30.

Thomas Lambert, of New Cut, Blackfriars, brass founder, and Charles William Rowley Richards, of Charlotte-street, Blackfriars, engineer, for "Improvements in cocks for drawing off liquids and gases."—April 30.

John Mercer, of Oakenshaw, Clayton le Moors, Lancashire, chemist, for "Improvements in scouring and cleaning wool and woolen fabrics, also in bleaching and clearing silk, cotton, and linen, and other fabrics."—May 2.

George Palliser, of Finsbury-place, for "Improvements in the construction of outside seats of carriages."—May 5.

William Longshaw, of Manchester, for "certain Improvements in machinery or apparatus for spinning and doubling cotton and other fibrous substances."—May 5.

Peter Carmichael, manager for Baxter Brothers and Co., Dundee, for "Improvements in hackling or dressing flax, hemp, and other fibrous substances, and improvements in machinery for rubbing, stretching, and equalising the breadth of cloth made from flax, hemp, jute, and other fibrous substances."—May 5.

George Riddett, of Ryde, Isle of Wight, upholsterer, for "Improvements in reading-tables."—May 5.

John Carter, of Fleur-de-lis-street, London, ivory merchant, for "Improvements in paddle-wheels."—May 5.

Alfred Vincent Newton, of Chancery-lane, mechanical draughtsman, for "certain Improvements in machinery for manufacturing screws." (Being a communication.)—May 5.

William Church, of Birmingham, for "certain Improvements in machinery, to be used in making candlestick pans, and various other articles which are usually produced wholly or in part by means of the process called stamping; and also in machinery for making sockets or tubes for candlesticks and tubes, or tubular articles applicable to various other purposes."—May 5.

William Pidding, of Wigmore-street, gentleman, for "an Improved process for preserving the flavour of coffee and cocoa, or of any preparations thereof, from the effects of the atmosphere."—May 5.

Thomas Melling, of the firm of Melling and Co., Rainhill, Lancashire, engineers, for "certain Improvements in steam engines, marine, stationary, and locomotive; and in machinery and apparatus connected therewith, parts of which are also applicable to regulating the flow of fluids generally."—May 7.

Edward Shepard, of Trafalgar-square, gentleman, for "certain Improvements in gates, doors, shutters, and other articles of the like construction, and in fastenings to be attached thereto."—May 7.

Mark Rollinson, of Brierly-hill, near Dudley, engineer, for "certain Improvements in steam-engines."—May 7.

Alexander Angus Croll, of Suffolk-street, Clerkenwell, chemist, for "Improvements in gas meters."—May 12.

Robert William Sievier, of Upper Holloway, gent., for "Improvements in printing."—May 13.

William Little, of 198, Strand, publisher of the "Illustrated London News," for "Improvements in machinery for printing."—May 12.

John Lloyd Bullock, of Conduit-street, Hanover-square, chemist, for "Improvements in the manufacture of quinine." A communication.—May 12.

Christopher Vane, of Frederick-street, London, gent., for "Improvements in apparatus employed when transmitting and drawing beer and ale."—May 13.

Charles Hancock, of Grosvenor-place, gent., for "certain improvements in the manufacture of gutta percha, and its application alone, and in combination with other substances."—May 15.

Henry Valentine Bartlett, of Sheffield, dentist, for "Improvements in artificial palates, teeth, and gums, and certain machinery employed in the manufacture thereof."—May 15.

Julius Jeffreys, of Norfolk-crescent, Hyde-park, gent., for "Improvements in steam-engine boilers and furnaces, and improvements in propelling vessels."—May 16.

William Rodger, of Shamfield-street, Chelsea, Lieutenant R. N., for "Improvements in anchors."—May 18.

George Duncan, engineer, Edinburgh, for "an improved method of making comfits confectionary, losenges, and all description of pan-goods, the machinery and apparatus for the manufacture of the same, or for any other article to which the said apparatus or machinery may be made applicable."—May 19.

Stephen Perry, of Woodland-place, St. John's-wood, gent., for "certain Improvements in the manufacture of rings, straps, bands and bandages, cords and string, and in their application to clockwork, to locks and other fastenings, to presses, to books, to paper-holders, to candle lamps, to window-sashes, to doors, to window-blinds, to seats and surfaces for lying and reclining upon."—May 19.

Alfred Markwick, of Langham-place, for "Improvements in the manufacture of epithems, used for medical and surgical purposes." A communication.—May 20.

Zachariah Major Parkes, of Peckham, surveyor, for "Improvements in the manufacture of coffins for the dead."—May 22.

Charles Thomas Lutwyche, of Birmingham, gold and silver chain maker, for "Improvements in the manufacture of porcelain buttons."—May 22.

Hugh Greaves, of Hulme, Manchester, engineer, for "Improvements in the construction of railways and the carriages to be used thereon."—May 22.

Charles Wright, of Southampton-row, Russell-square, boot-maker, for "certain Improvements in the manufacture of boots and shoes."—May 22.

John Walker Wilkins, of Stanhope-street, Hampstead-road, for "certain Improvements in water-closets."—May 26.

Charles Bertram, of Gateshead, Durham, Esq., for "certain Improvements in the manufacture of artificial fuel, and in the application of the residual products to useful purposes."—May 26.

Timothy Kenrick, of West Bromwich, ironfounder, for "Improvement in glazing and enamelling the surfaces of cast iron."—May 26.

James Montgomery, of Salisbury-street, for "certain Improvements in the construction of steam-boilers and steam engines, and in steam-vessels, and in the machinery for propelling the same."—May 26.

Edward Alfred Cowper, of Smethwick, near Birmingham, engineer, for "Improvements in the manufacture of railway chairs."—May 26.

William Mayo, of Silver-street, London, manufacturer of mineral waters, for "Improvements in the manufacture of aerated liquids, and in bottling aerated and other liquids."—May 26.

"BLASCO GARAY" STEAM SHIP.—The engines of this new vessel are remarkable for being by far the largest yet constructed on the oscillating principle. They are 350 horses' power; the engineers are Messrs. Miller and Ravenhill. An experimental excursion was made on the 14th of May, and proved perfectly satisfactory. The regularity and smoothness with which the enormous cylinders oscillated on their trunnions was really surprising. The principal peculiarity of construction to be noted is that the valves and ports are placed over the inner trunnions, and oscillate in the same direction as the cylinders: the advantage of this method is that the necessity of having large balance weights is avoided. The equability of the motion of every part of the engine is a most gratifying proof of the extraordinary perfection to which English workmanship has attained. Messrs. Wigram and Son are the Builders. She is intended for the Spanish Government.

The following are the principal dimensions:—

Length between the perpendiculars	187	
——— over all	209	
	ft.	in.
Breadth between the paddle-boxes	31	11
Depth of hold.	20	
Mean depth with machinery on board . . .	10	6
Diameter of cylinders	0	68
Length of stroke	6	

Messrs. Miller and Co. have undertaken to construct for the Oriental Steam Company three pairs of oscillating engines, on the same plan, but of still larger dimensions. The cylinders are to be of 76 inches diameter, and the length of stroke 7 feet.

CORRESPONDENTS.

"A Working Mechanic" (Newcastle on Tyne).—We are not certain that we correctly understand the construction of the proposed mercurial air-pump. Without the mercury be allowed to run out at the bottom of the conical tube, the mere turning of a screw will not make it descend. In any case, the mercury in the conical tube will descend no lower than the point where the difference of the heights in the conical and the upright tubes balances the difference between the pressure of air in the receiver and the external air.

"Messrs. Blair and Phillips" have sent us a very pleasing design for a railway bridge. It is not our custom to publish designs for structures not actually erected or about to be erected, but the inspection of the drawing which we have had the pleasure of receiving reflects credit on the taste of the designers, and induces us to think that we should agree better with them on architectural than on mechanical subjects.

"J. Huntingdon" (Wanstead, Essex).—When an engine is travelling with uniform velocity, the pressure on the piston depends not on the pressure on the boiler, but on the *load drawn*. If the size of the train be such as to produce a resistance of A lb. per inch to the piston, the pressure on the piston must also be A lb. per inch. If it be more, the speed will be accellerated; if less, diminished. If, therefore, as is always the case, the boiler pressure exceed A lb., the steam must be dilated in passing to the cylinder. The whole theory is correctly laid down in De Pambour. The ratio 10 : 16 must have been arrived at by a *statical* process: the problem is a dynamical one. The only correct way of determining directly the relation of the force of the driving-wheel to that of the piston, is by equating the impressed and effective forces by D'Alembert's principle. A much more simple method is however to compare the respective distances traversed by the piston and a point in the circumference of the driving-wheel in equal times. For instance, suppose the length of the stroke 18 inches and the circumference of the driving-wheel 17 feet: while the piston makes a double stroke (3 feet), the engine, if there be no slipping, travels a distance equal to the circumference, 17 feet. Consequently, the ratio of the average force of the driving wheel to that of the piston is (neglecting the friction and inertia of the crank) 17 : 3. *If* l be the length of the stroke, and D the diameter of the wheel, the relation of the force of the piston to that of the wheel is $\pi D : 2l$ or $D : l \cdot 6367$. Mr. Huntington makes it $D : l \cdot 8$, which is too large by more than one-fourth of the real value.

"Mr. R. H. Sharp."—Received with thanks and will appear next month.

ERRATA.—In the paper on the Aust Passage Bridge,—

Page 122, column 1, line 10 from bottom, dele the full stop.

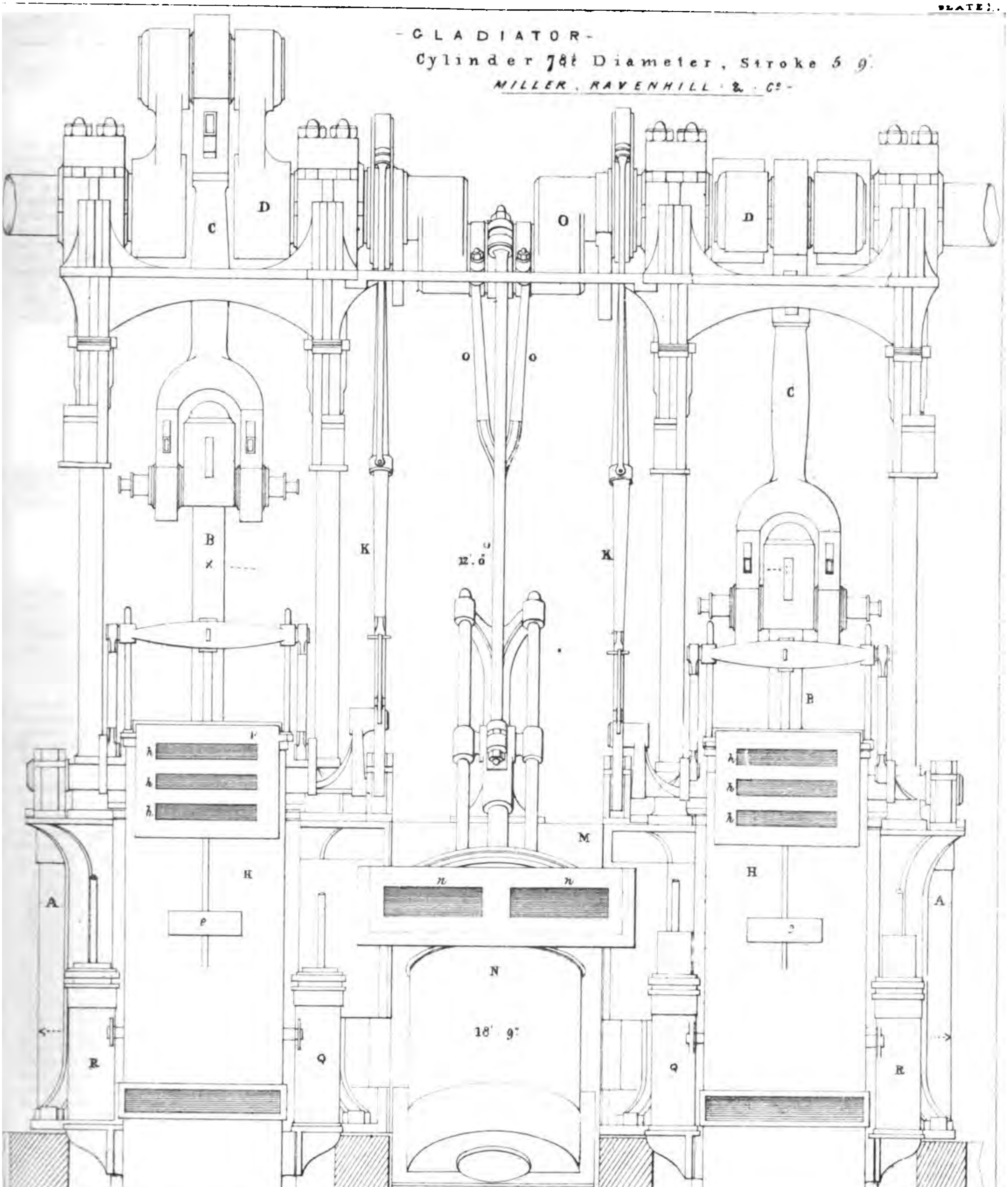
„ column 2, line 29 and 31 from bottom for $(8+1)$, read $(s+1)$.

„ column 2, line 35 from bottom for (height)s read (height)^s

- GLADIATOR -

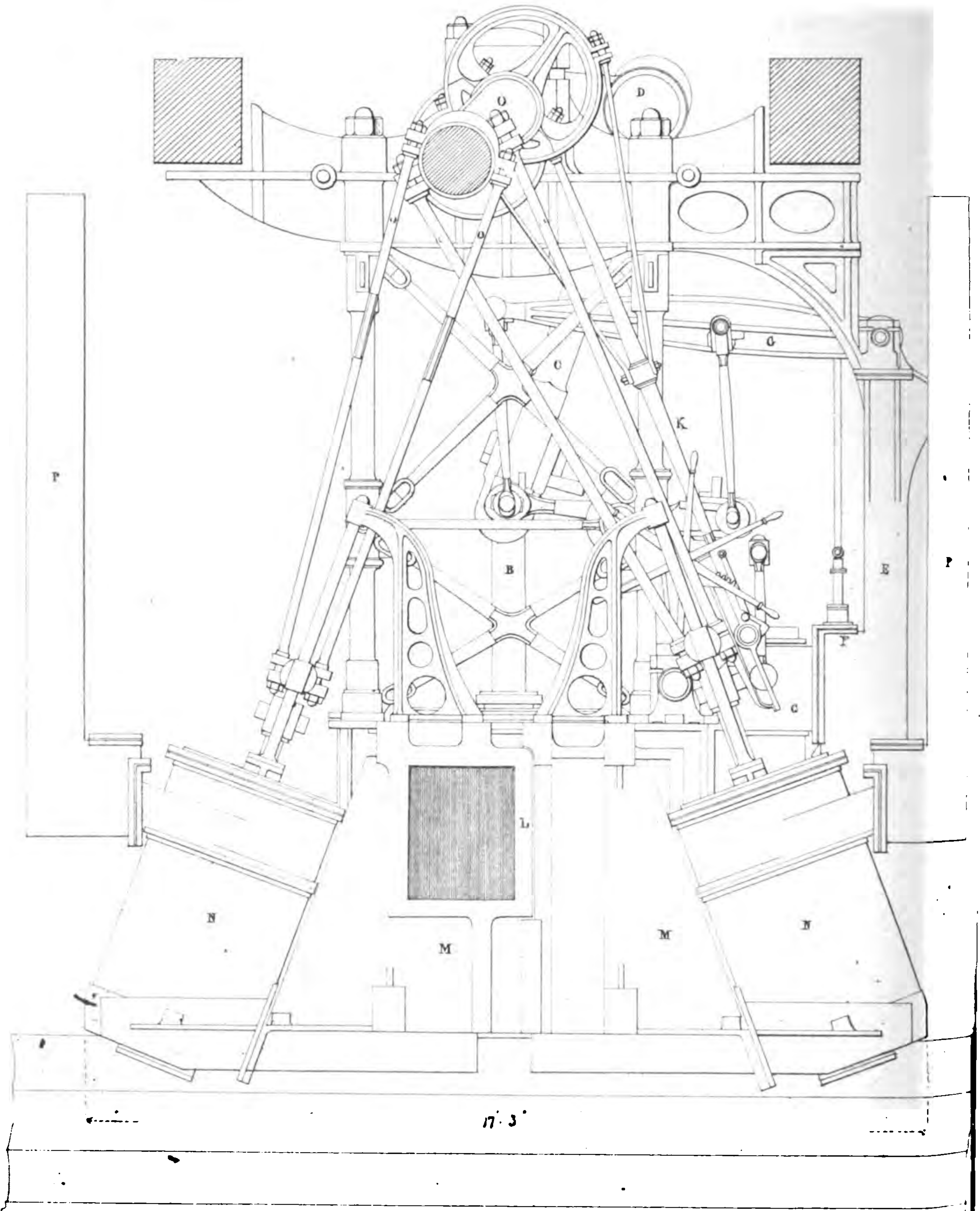
Cylinder 7ft Diameter, Stroke 5 9

MILLER, RAVENHILL & Co -



TRANSVERSE ELEVATION

ENGINES OF HER MAJESTY'S STEAM FRIGATE-



LONGITUDINAL ELEVATION

G. Bagster. -

THE ENGINES OF H. M. STEAM FRIGATE, "GLADIATOR."

(With Two Engravings, Plates IX. and X.)

The gradual improvement of direct action engines, and the general adoption of them in the place of beam engines in steam navigation are subjects of the greatest importance to the mechanical engineer. On the first introduction of direct action engines it was imagined that they could never be made to work so steadily as those of the original form, and that consequently the application of the principle must be extremely limited in extent. It was confidently predicted that in large engines, the great mass of metal pot in motion must cause such a vibration, if the beam were dispensed with, as would speedily cause the pistons, slides, &c., to work untruly.

It has been found, however, by actual experience, that the evil in question may be entirely removed by accuracy of workmanship, and by skill in the arrangement of the working parts. And on the other hand the diminution of the weight of the engines and of the space occupied by it, are advantages of so great importance in navigation, that they far outweigh the supposed disadvantage of removing the beam.

The Gladiator, one of the vessels forming the "Squadron of Evolution," is a beautiful example of the perfection of workmanship exhibited in the construction of British marine engines.

Before, however, describing those peculiarities in the engines of the Gladiator, which are illustrated in the accompanying plates, we wish to remark with respect to the observations which have been made on the performances of the steam vessels of the Squadron of Evolution, that those remarks apply exclusively to the powers of the steam vessels as sailers when deprived of the assistance of their engines. To compare the powers of a steam vessel as a sailer with those of a ship built to be propelled by its sails exclusively, seems to us as absurd as to compare the speed of two animals possessing altogether different organs of locomotion. It can be no matter of wonder that a vessel containing the enormous weight of marine engines, and built of a form suitable for containing them, should not sail so fast as one which does not contain this load, and is built of the form best adapted for sailing. Between steam-ships and sail-ships no correct comparison can be drawn.* Not only are their means of propulsion entirely different, but the circumstances under which each acts most usefully, are altogether dissimilar, so that for the purposes of war each in its turn would be invaluable, where the other would be inefficient. The most rational method therefore seems to be to keep the individual characteristics of the two classes of vessels perfectly distinct,—to render each as perfect as possible in those qualities which constitute its peculiar advantages—in other words, to speak to those whom we have the most interest in addressing, to render the war-steamer as perfect as possible *as a steamer*, and not to injure her powers by injudicious attempts of combining with them the peculiar qualities of sailing vessels.

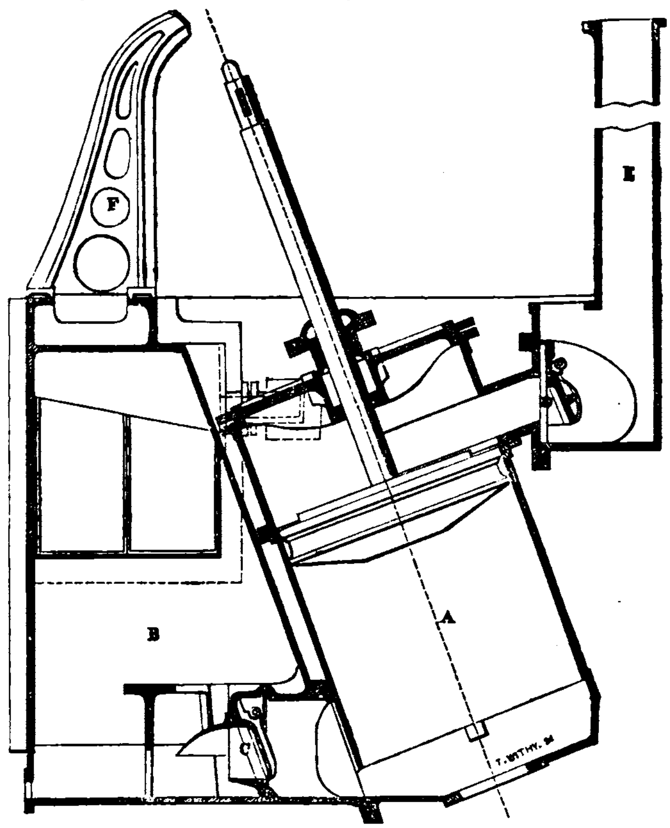
The engines of the Gladiator were constructed by the well-known firm of Miller, Ravenhill, and Co., of Blackwall. The principal feature of these engines is their compactness, the cranks, and consequently the cylinders being brought close to each other, to give deck room for moving the cannons fore and aft. The air pumps are constructed on a principle patented by Mr. Miller, being inclined towards each other, and worked by a crank common to both, on the same shaft with the cylinder cranks.

The following are the references, Plates IX and X.

A A, Cylinders 78¾ inches in diameter, 5 feet 9 inch stroke.
B B, Piston rods.
C C, Connecting rods.
D D, Cranks on working shaft.
E, Upright steam-pipe. At its lower end are brackets *e e*, cast on the slide-valve casing, to support the steam-pipe.
F, Expansion valve box.
G, Beam working the refrigerator pump of Howard's patent condensing apparatus. The beam, of which the bearings are supported by the upright steam-pipe, forms part of the parallel motion.
H, Slide valve casing. *h h h*, Openings from the steam-pipes on which the expansion valves work.
I I, Cross-bar, and K K, Eccentric rods, for working the slide valves.
L, Opening between slide valve casing and condenser.
M M, Condensers.
N N, Air-pumps. *n n*, Delivering valve openings.
O, Crank for working air pumps.
P P, Hot water cisterns. Q Q, Feed pumps. R R, Bilge pumps.

The annexed diagram represents a section of one of the air-pumps and condenser of the Gladiator.

Fig. 1.—Section of one of the Air Pumps and Condenser of the Gladiator.

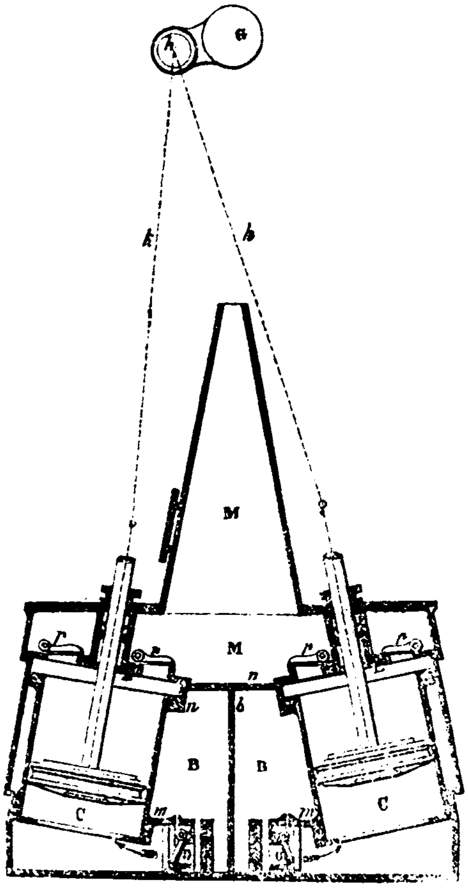


A, Air-pump.—B, Part of condenser.—C, Foot-valve.—D, Delivering valve.—E, Hot water cistern.—F, Bracket for supporting guide-rods for air-pump cross-bar.

The following extract from the specification of a Patent, granted March 22, 1842, to Mr. Joseph Miller, will further explain the construction of the air-pumps and condenser.

The engraving fig. 2, show a vertical section of the condensers B B, and air-pumps C C, disposed within the condensers, and between the steam cylinders, in a different manner to that hereinbefore described, one pump being before the other, instead of the two pumps being side by side. The pumps C C are inclined from the vertical, in contrary directions, so that the direction of the centre line of each pump will point to the centre of the rotative axis G, and both pumps are worked by the same crank *h*, on that axis, by means of two crank rods *k k*, of which only the centre lines are shown dotted, and the upper ends whereof may be applied side by side on the pin of that crank *h*, one of those crank-rods *k* being for working one pump C, and the other of those crank-rods *k* for working the other pump C. In case of the two crank rods being so applied, side by side, on the said pin of the crank, then the two air pumps (when viewed from the front) cannot stand exactly in the same vertical plane one with the other, but the centre line of one pump will be as much at one side of the centre line of the other pump as is requisite to suit the crank-rods *k k*, in case they are one at the side of the other, in order that they may both work upon the same crank-pin *h*, as already mentioned ; or one of the crank, rods *k k* may be made forked at the upper end, when it is applied upon the crank-pin, with two joints on that pin, side by side, and including the joint of the other crank-rod between them, and in such case the centre lines of both air-pumps may be in the same vertical plane. In such an arrangement of the air-pumps, the steam cylinders will stand nearer together, and the middle portion G of the rotative axis will be very short, and there will be only one crank *h* on that middle portion. The condensers will be narrower in the direction between the cylinders, but longer in the opposite direction. The vertical partition *b*, by which the condenser is divided into two compartments or distinct condensers, may stand in the direction from the centre of one steam cylinder to the centre of the other, provided that, by means of another partition or a branch of one partition suitably disposed within the condenser, one of the eduction passages G of one of the cylinders cut only one of those passages, is prolonged and continued withinside the condenser beyond or through the partition *b*, so as to communicate very freely from that said cylinder to that condenser or compartment of the condenser which is most remote from the sliding valves and the eduction passages G. The manner of fixing the air-pums C C into apertures through partitions *m* and *n*, and the manner of placing the foot-valves *o o*, is much the same as already described, except that instead of the said partitions being horizontal, they are as much inclined as will suit the inclining position of the air-pumps C C. The discharge valves p p may be applied at the top of the cover L of each air-pump to discharge the water into the space above the upper partition n, which space constitutes the hot well M, and may be common to both pumps. The condensers will have the same kind of flanges, with vertical surfaces of contact and union, with the corresponding surfaces of the two steam cylinders, as already described, except that those surfaces will not be quite at the angles of the condensers when the same are made as shown, but the mode of uniting the two steam cylinders to the condensers by such surfaces, with bolts through the flanges thereof, will be the same as hereinbefore described, and need not be repeated. And note, it is not necessary that the inclined air-pumps should be put within the condenser, as is there represented, for each pump may be joined to the condenser at bottom, beneath the lower partition m, by means of a branch projecting laterally from the bottom of the pump, or else projecting laterally from the condenser, and by another branch projecting from the top of the pump it may be connected with the upper part of the condenser above the upper partition n. Those branches

Fig. 2.—Section of Air Pumps and Condensers.



being united to the condenser at the lower and at the upper parts thereof, in a similar manner to that whereby the air-pump of a marine steam engine, of the kind heretofore made by Messrs. Boulton and Watt, with side-levers, is most commonly connected to the condenser and hot-well of such an engine, except that the pumps will be inclined instead of being vertical, and the pumps may, in that last-mentioned case, be somewhat more inclined than they are represented, if that is requisite, in order to give as much more space of condenser between the two pumps as will give the required capacity of condenser. The lower branch by which each air-pump is joined to the lower part of the condenser (whether that branch is formed as part of the pump, or as part of the condenser,) will join to the condenser below the lower partition m, and the foot-valve o may be within the interior of the condenser, or it may be within the lower branch thereof, to which the air-pump is joined. If the said lower branch is formed in the same casting or piece of metal with the condenser, it may project out from the lower part of the condenser, and the air-pump may join thereto, with a bottom flange around the lower end of the pump, or if the branch is formed with the air-pump, it may join laterally to the front side of the condenser, at the lower part of that side. The branch at the upper part of the air-pump will have the discharge-valve or valves applied to it, those valves being within the hot well, which hot well may either be a space M within the condenser at the upper part thereof, above the upper partition, or inside of the condenser, or the discharge valves may be in a hot well, which is formed by a vessel distinct from the condenser. Although two distinct condensers and two distinct air-pumps have been described (that being preferable in most cases), nevertheless, that is not essential to my improved arrangement and combination; but the same is equally applicable if the condenser is made without the partition b so as to be only one condenser, and with only one large air-pump, equivalent in its capacity to the two air-pumps represented in the drawing."

NEW METROPOLITAN CHURCHES.

Westbourne Terrace, Hyde Park.—The plan of this church is nearly a rectangle, and comprises a nave with low pitched roofs, north and south aisles, with lean-to roofs, a chancel, an octagonal vestry at the north-east angle of the church, and a tower and spire at the west end of the nave. The spire is very lofty, and rises to a height of 212 feet. The length of the church from east to west is 150 feet.

In the interior of the church the nave is divided from the aisles by piers which are intersected at mid-height by galleries, which of course partially obstruct the north and south windows. There is also an organ gallery which communicates with the staircases by doors having straight jambs and lintels like the doors of an ordinary dwelling house.

The walls of the church, the piers, the groined roofs, the walls of the porches, staircases, &c. are all coated with stucco, on which are drawn lines to mimic the jointing of masonry; the hood mouldings of the windows are run in vile patent cement, the bosses of the roof, the capitals and bases of the columns are all of the same material—moulded first and stuck on afterwards. You see lying about the church the halves of bases, black dingy things, not yet whitened by drying, that resemble detached *hoofs* rather than real architectural members—these are to be fitted into their places directly they are dry, and if coated with a delicate layer of colour will defy detection.—Boz describes one of his humble heroines who had small means of gratifying her love of dress and consoled herself with the reflection that "a brave show may be made with ribbands for sixpence."

The ceilings of the church are quite dazzling with white wash. The connoisseur in imitations will not fail to admire also the stained deal panelling, and probably will not object to the indentations in the plaster which suggest sham windows.

The architecture of the exterior perfectly corresponds to that of the interior. To those who have familiarized themselves with the architecture of our English country churches, the tracery of the windows of the new church might appear of somewhat "formal cut," but then it is very showy for the money, and an approved specimen of *pattern* Gothic. Beneath the parapet, which is panelled, is a row of grotesque masks; for the architect, determined to have at least some point of resemblance to ancient Christian art, has selected for imitation the least admirable feature of it—those barbarous and ridiculous imitations of the human form which were excusable in an age, when a familiar connection of solemn and ludicrous subjects was tolerated, but which would now be pronounced impious or indecent. But here the disciple has out-done his masters; in his reverence for antiquity he has produced forms more monstrous than ever disfigured ancient freemasonry—Bacchanalian visages with huge tongues hanging below their chins, or with fists forced into their distended cheeks, and similar distortions which might make the fortune of the clown in a penny theatre but seem rather out of place in a religious edifice. To compensate however for these barbarities we have over each porch an angel, who fervently clasps a shield to his breast, and by his beaming countenance exhibits a perfect ecstasy of pious beatitude.

The general character of the architecture is ostentation in the forms and unreality in the materials—two things, by the by, which always accompany each other; for where fictitious and dishonest materials are employed, the fatal facility which they afford for introducing ornament is usually too strong a temptation for vulgar display to be easily resisted. Of this truth the multitude of terraces and crescents which are springing up in the vicinity of the new church are lamentable examples. They look uncommonly showy and fine in the lithographic views which are got up for the purpose of letting the houses, but we trust that the time is not distant when by the force of universal public detestation this common-place architecture will be abolished for ever.

South Hackney.—A new church is being erected here from the design of Mr. E. C. Hakewill, and although the building is not in a very advanced state, the progress made is sufficient to lead us to hope that this new church when completed will be an additional proof of the advance made in the knowledge of Christian architecture during the last few years.

South Hackney New Church.

The plan of the building shows a nave, transepts and chancel, and a western tower. The archway of the entrance in the tower is *seven feet* in depth,—a gratifying contrast to the miserably shallow doorways of some of our recent churches. The following will be the principal dimensions of this Church when completed:—

Length from east to west internally	169 feet.
Width of nave and aisles	61 „
Length from north to south in the transepts	92 „
Width of the transepts	34 „
Height internally to the top of the walls	37 „
Height to apex of the roof	65 „
Height of tower and spire	200 „

Unlike the churches which we had occasion to notice last month, this edifice will have north and south windows in the aisles, and will not be lighted by a clerestory exclusively. We should however like to have seen more light admitted from the lower, and less from the upper, windows. It is not necessary to repeat what we have already insisted upon, that to let in a flood of light near the roof is to admit it to the greatest disadvantage as regards picturesque effect. The roofs ought to appear dim, shadowy and obscure—especially in a church of the early style here chosen; it was not until the decline of art in the Perpendicular period that the upper parts of churches were brilliantly illuminated.

No criticism is complete without it detect some faults, we must therefore endeavour to find some, though we confess that our feeling in favour of the general merits of Mr. Hakewill's design renders the task somewhat difficult. The tower is perhaps too much cut up into parts by string courses, &c.; some of these might be omitted with advantage, for a tower should have the character of massiveness and strength, and consequently the parts should be large and well defined. Neither do we much admire the position of the statues at the base of the spire: there is always an idea of awkwardness and insecurity attached to a statue perched upon a point, or in any way overhanging its base. In the drawing which Mr. Hakewill has been kind enough to send us, the form of the flying buttresses seemed rather formal, and the manner in which the upper parts of the buttresses at the angles of the transept met the wall appeared abrupt.

However, these are matters of detail which the architect will be able to alter, if he see fit, during the progress of the works; the general character of the church, the massiveness and boldness of the features, and the consequent depth of the shadows contrast very advantageously with the *flatness* and showiness which modern churches too frequently exhibit. The materials are Kentish ragstone, with Bath-stone dressings; the good taste of the architect will, we are confident, lead him to reject fictitious or imitative materials.

Our acknowledgements are due to several architects, to whom we have applied, for the readiness with which they have afforded information of churches in the course of erection under their superintendence. We shall feel obliged by receiving notices of new churches in or near London: these notices should be accompanied by a list of principal dimensions, and must not contain any remarks of a critical character. We shall also be glad to publish views of churches of which the general composition is good, or illustrations of interesting details; in the latter the jointing of the masonry should always be distinctly shown.

ROYAL ACADEMY EXHIBITION: ARCHITECTURE.

SECOND NOTICE.

It might be imagined that of Interiors there would be an abundance rather than a deficiency, because each single building contains a great many divisions within, and although only two or three of the principal parts or apartments may be of any architectural importance, subjects of that kind would still greatly out number the buildings themselves. Nevertheless, such drawings—whether designs or views—are rarities and exceptions, notwithstanding that designs for rooms and their decorations would be somewhat less chimerical than those for cathedrals and other buildings on "monster" scale. Unless the private mansions and other edifices, of which we meet with drawings at the exhibitions, be totally devoid of architectural interest within, there must be a great deal that is withheld from us; which is the more to be regretted, because it is through drawings alone that the public can become acquainted with what lies on the other side of the threshold of a private residence. We should therefore have been thankful had we been favoured by the sight of a drawing or two—nay, even of a single one, in evidence of the taste displayed by the noble President of the Institute of British architects, in his newly fitted-up mansion, Wrest House. Either it has been fulsomely flattered by newspaper paragraphs, and the "sumptuousness" which, it seems, characterises it, is after all, little better than extravagantly costly commonplace, or there must be something in it well worth seeing; whereas now we have neither verbal nor graphic description to give us any idea of what it really is. Earl de Grey, however, chooses to conceal his light under a bushel,—at least, from such as ourselves, and by so doing he shows one thing—that he is oblivious of, or else indifferent to, his connection with architecture as the President of the Institute;—whose members, by the by, require to be spurred on to support the Academy's exhibitions.

After these very *grumbling* remarks, it may be some relief when we say that the present season is not more barren of Interiors than usual, for which we have chiefly to thank Mr. Sang, who exhibits four subjects of the kind, Nos. 1262, 1336, 1337, and 1358, the first of them a sectional view of the ambulatory of the merchants' area in the Royal Exchange, and the other three, views of the Grand Staircase, Lower Hall, and Upper Hall of the Conservative Club-house. These last are especially welcome, because the Club-house is not open to every one, as the Exchange is, and even those who like ourselves have had the opportunity of going over the building, cannot have such favour renewed at pleasure. Yet, for seeing any drawings of it at all we are perhaps entirely indebted to Mr. Sang's share in the work, which, we hardly need say, is confined to the encaustic polychromic decorations of the architecture. Except that they are in perspective, the drawings themselves make very little more pretension to pictorial expression than coloured sections would do, artist-like treatment and effect of light and shade being renounced in them for the purpose of showing with all possible distinctness the actual colours and ornamental patterns. Hence they are to be looked upon not as pictures, but merely as graphic descriptions and explanations of those parts of the interior which they represent. As respects the decoration, we think it is rather too minute and showy to be altogether in character for the places where it is introduced, the most effect of all in the building being thrown into what requires to be rather subdued than exaggerated, and not allowed to overpower all that follows. What strikes us as a fault in the general design—one, however, for which Mr. Sang is not answerable—is the want of stained glass of some kind in the glazed skylight dome of the upper hall, which is now rather too much of a blank, and which must, we think, have not only a blank, but even a black and therefore dismal look by night, when it must show as a dark yawning void overhead. Such, indeed, would still have been the case had it been filled in with painted or embossed glass, unless it could also have been lighted of an evening from the outside; wherefore it would perhaps have been better to close the opening of the dome by a cove and *plafond* or horizontal ceiling, with transparent panels of painted glass, letting the present dome be an external skylight, and within the intermediate space there might have been gas-burners to shed light through the panels of the ceiling by night.

But our pen is running away from us, and we are running away from our proper subject. So let us return to the Exhibition.—No. 1160, "A Library," (W. W. Deane) possesses much merit in its idea, and a very unusual degree of scenic effect is produced by the semicircular recess lighted from above and separated from the room by a screen of Corinthian columns (forming five open intercolumns); which order is continued by antæ on the other walls, those on the window side being placed not as pilasters against the piers, but at their angles, with the draperies hung within the embrasures or window recesses, so that, instead of at all concealing, those curtains serve to relieve and set off the architectural forms. So far, this design seems to us to fulfil even better than No. 1270 does the title given to the latter, viz., "A design to illustrate an architectural arrangement of draperies in a drawing-room," (J. Dwyer). Though drawings of the kind are so few that as much show as possible should be made with them, Mr Dwyer's is so placed as to frustrate examination, but were it not for the intimation in the catalogue we should never have suspected it to be intended as a study of "arrangement of draperies," there being nothing at all novel—as far as we can perceive—in that respect, except it be that what is either an open doorway or mirror at the end of the room, has a drapery corresponding with those of the windows.—Nos. 1279 and 1355 show us the "Staircase and Music Hall of Mr. Hullah's Singing School." (W. Westmacott); but where the building is, or is to be, is not said. The style partakes of Tudor, modernized and enfeebled in character; however, we have not a right to expect much in what we suppose is only the speculation of a private individual. Less indulgently are we disposed towards the very next No., viz. 1356, "The hall and staircase of a gentleman's residence executing from the designs and under the superintendence of G. Mair." In its general idea it is rather the reverse of what would be thought of as suitable in a residence at the present day, it being upon the old system of hall and staircase thrown together, so as to form a lofty space that seems to occupy too much of the house, unless it be a very large one. Neither is space here made to contribute to display; while as to character and detail, there is more of what is faulty, objectionable, and inconvenient in the Elizabethan style, than of what is meritorious in it, and applicable in modern houses; in short, it is rather what one would preserve, had it previously existed, than now produce.—No. 1312, "Interior of the Upper Chapel, San Benedetto, Subiaco" (D. Wyatt), is the finest picture drawing in the room—others equal to it we may occasionally have seen—certainly some that we should prefer in point of subject; for instance, the Loggia of the Villa Madama, by G. Moore,—but for power and mastery of execution, we cannot call to recollection anything superior. With the force of oil it has a clearness which we seldom find in the very best architectural pictures in oil, although there seems to be nothing to hinder the highest finish and most deceptive degree of imitation being obtained in them, just as well as in still-life subjects—seldom worth the skill and labour bestowed upon them. This production of Mr. D. Wyatt's—whom we can hardly suppose to be a young hand, although we never met with his name before—is a perfect study for its execution, all the details and different materials being most admirably expressed; yet the whole is in perfect keeping.—No. 1342, "Milan Cathedral," (F. W. Stent) is another interior not a little remarkable, but more so for the singularity than the excellence of its execution, force being here exaggerated into caricature, for the tone of the whole is so exceedingly dark, and the lights which fall upon a few prominent parts, so unnaturally brilliant, that the latter look like so many pieces of mother-of-pearl inlaid on a ground of ebony.—No. 1258, "Interior of the Church of the Apostles, Rome," (J. P. Crew), is a drawing marked by the directly contrary fault of want of depth and solidity, not however to such a degree as to be therefore faulty in itself, and we only wish the artist had employed his pencil upon a better subject, the building being in poor and tawdry taste:—however, rather this than so very stale a subject as that of Mr. Crew's other drawing, (No. 1248, A View of the Coliseum from the Arch of Titus). Sadly at a loss for subjects for interiors must architectural draftsmen be, when they give us such a one as No. 1176, than which one more destitute of merit or interest of any kind could hardly have been found in all London. Had the author of that production walked into Moses' shop, he might have found a rather striking subject, at all events something quite fresh, but that any one should think it worth while now to show us the "Interior of the Chapel of the Foundling Hospital," is to us perfectly unaccountable. We should have been very suspicious of its being merely a copy from a print.

There are still one or two drawings of interiors, which we have not yet mentioned, because they belong rather to the class of designs for churches;—of which it will be expected that we should say something, yet it is but little that we have to say, there being few of them at all distinguished by any thing particularly good in them, or the contrary, except it happen to be by the sort of merits and defects that are extolled or vituperated by the "Ecclesiologist." What strikes us as rather singular, is, that among them there are scarcely any drawings of Churches or Chapels in or near the metropolis. St. John's, Charlotte-street, Fitzroy-square; St. Michael's, Pimlico; St. Andrew's, Well's-street; the Catholic Church, Farm-street; Bedford Chapel, the newly erected campanile of the Catholic Chapel in Spanish-place, Manchester-square—not one of these are in the Exhibition. Those which are, are exclusively in the Gothic or mediæval style, there being not a single drawing for church or chapel in any other, although Grecian or rather Greco-Italian seems fitter for buildings of the kind in towns, and so far from being prejudiced against such style, by the wretched and insipid productions in it twenty years ago, they might now be serviceable to us as warnings, and might convince us that should we resume the style at all, we ought to treat it very differently from what it then was. As to Gothic, it is undoubtedly very much better understood and practised than it was a quarter of a century ago or even much less, still it seems now to be got into a sort of respectable mannerism and method. Instead of design being left to be moulded by circumstances, every part of a church must be shaped according to certain arbitrary regulations; there must be this thing or that, though so far from its being at all required, inconvenience should be incurred by adopting it. Lucky is it for Eton College Chapel that it is not a modern structure, since it falls short of the present orthodox standard, in having neither aisles nor chancel, nor spire, nor even tower; neither has it more than a single range of windows, and those at a considerable height from the floor; yet it is not only a very fine specimen of architecture both internally and externally—but also exceedingly well suited for the Protestant worship. Nor is it without reason that we here mention it, there being three designs (1288, 1290, and 1296) by J. M. Derick, and J. Shaw, for restoring the interior.—No. 1260, described only as "View of a Church, designed by G. Alexander," without the name of its locality;—and Nos. 1295 and 1307, exterior and interior of "St. James, Seacroft, near Leeds, Yorkshire," (T. Hellyer,) are among the best productions of this class. But none displays more forcibly the enviable talent of being able to infuse a strong degree of character and originality into what in most hands would prove a very insignificant subject,—than No. 1329, "Healy Church, now erecting in the parish of Masham, Yorkshire," (E. B. Lamb). Small as it is in dimensions, and simple as it is in style, this little edifice is so full of piquant expression that it might pass for the *ideal* of an English *village* church. There is a great deal of effect with scarcely any thing to account for it,—it being that of a felicitous aggregate, and artist-like combination of parts. A design of this kind is a very severe reproach upon the soulless and idealess compounds of vulgar tawdry calling themselves designs for cathedrals and townhalls, which however we will pass by, in mercy, without pointing to them by their numbers or names.—The show of models this season is even poorer than usual, and things of the sort are always so badly shown at the Academy, so huddled up and jumbled together, that we almost wonder any should be sent at all.

SUPPRESSION OF SMOKE.

A report has been recently addressed to the Government by Sir Henry De la Beche and Dr. Lyon Playfair, respecting the means and effects of preventing the smoke of furnaces. The following extracts will sufficiently explain the conclusions arrived at.

"The general principles upon which the combustion, or rather the prevention of smoke, may be effected are now well known, and admitted to be applicable in practice. Smoke consists of vapours produced by the partial combustion or distillation of coal, carrying up small particles of the fuel in mechanical suspension, and depositing, by the combustion of one of their constituents, carbonaceous matter in a fine state of division. The mode of preventing this smoke is to admit a sufficient quantity of air to effect the combustion of the carbonaceous matter, when the vapours are of a sufficiently elevated temperature to unite entirely with the oxygen of the air. If the temperature be not sufficiently elevated, the hydrogen of the vapours alone is consumed, and the carbon is separated in the fine state of division referred to. The gases produced by the complete combustion of fuel are colourless and invisible, and therefore do not come under the definition of the term smoke.

"As the prevention of smoke implies the complete combustion of fuel, the result, as an abstract statement, always is, that more heat is generated, and a saving of fuel effected, when it is so consumed as to prevent the emission of smoke; but although this theoretical conclusion is undoubtedly correct, the practical results are not always consonant with this statement.

"In consuming smoke in the usual way a quantity of cold air is introduced into the fire, and as this must be heated up to the temperature of the surrounding fuel, the loss of the latter may be equal to, or even greater than, the saving of the fuel from the combustion of the products of distillation. This often results in the careless use of furnaces constructed on the principle of smoke prevention, and thus leads to the contradictory statements given by those who have used such furnaces. But in all carefully conducted experiments the saving of fuel has been considerable, and the reason of this will be at once perceived, when it is considered that in addition to the combustion of the products of distillation there is a large amount of fuel saved by the combustion of a gas called carbonic oxide, formed by the proper product of combustion, carbonic acid, taking up in its passage through the incandescent fuel, another portion of carbon, which escapes useless as regards the production of heat, unless burned by the air introduced at the bridge of the furnace, for the purpose of consuming the products of distillation.

"From these considerations, and from experiments conducted under our inspection, with a view to determine this point to our satisfaction, we arrive at the conclusion, that although from careless management of fires there is often no saving, and that indeed there is frequently a loss of heat in the prevention of smoke, still that with careful management the prevention of smoke is in many cases attended with, and may in most cases be made to produce, an economy of fuel.

"It may be unnecessary to remind your lordship that the cause of the emission of smoke in manufactories may be classed under three different heads, the relative importance of which involves very different considerations in any attempt to legislate for its prevention. These are—1. The want of proper construction and adjustment between the fire-places and the boilers, and the disproportionate size of the latter to the amount of work which they are expected to perform;—2. The deficiency of draught, and improper construction of the flues leading to a chimney of inadequate height or capacity;—3. The carelessness of stoking and management by those entrusted with the charge of the fire-places and boilers."

It cannot for a moment be questioned, that the continued emission of smoke is an unnecessary consequence of the combustion of fuel, and that, as an abstract statement, it can be dispensed with. But your lordship will perceive that there are grave difficulties connected with a general law to the effect that it shall be unlawful for chimnies, after a certain date, to emit smoke. With regard to steam-engines, the processes for the prevention of smoke have been matured, and in very many instances successfully employed. In this case, therefore, a law to that effect could be most easily and promptly carried out. In other cases mentioned in Lord Lincoln's letter, such as distilleries, dye-works, &c., the legislature has already granted powers in the Manchester Local Act; and as there are certain instances in which processes for the prevention of smoke have with them proved successful, it may be anticipated that the nuisance arising from these sources may be much abated, if they be subjected to the general law with that forbearance and caution which, under certain cases, is so advisable. There are certain processes in glass-works, iron-furnaces, and potteries, in which it is neither possible nor desirable to apply a general law for the prevention of smoke; although the nuisance may be partially mitigated, by causing the steam-engines employed in them to be so constructed as not to emit smoke.

It is useless to expect, in the present state of our knowledge, that any law can be practically applied to the fire-places of common houses, which, in a large town like London, contribute very materially to the pollution of the atmosphere; but it may confidently be expected, that by a wise administration of a legislative enactment, carefully framed, a great progressive diminution of the smoke of large manufacturing towns will be effected, and that the most happy results will thus flow from this improvement, in the increased health and moral feeling of their population, the intimate connection of which with facilities for cleanliness has been so often pointed out.

PLATE-GLASS MAKING IN ENGLAND IN 1846, CONTRASTED WITH WHAT IT WAS IN 1827.

(Compiled from authentic data by Henry Howard, Blackwall, and 4, Railway-Place, Fenchurch-street.—1846.

In 1827	In 1846.
Coals in London were about 31s. 6d. per chaldron in the Pool, which, with lighterage, wharfage, and cartage to the works, rendered them about 40s. per chaldron, or 30s. per ton.	Coals are landed at works near London at about 13s. per ton.
An annealing kiln contained 200 feet.	An annealing kiln contains 400 feet.
A casting furnace produced, say 1,200 feet per week.	A casting furnace produces 4,000 feet per week.
Hooded or covered pots were used for melting the glass, containing about 12 cwt. each.	Open pots are used, requiring less fuel, and containing about 20 cwt. each.
Pearlashes were at a high price, and heavy duty on alkali made therefrom. Pearlashes were in 1836, £43 per ton.	Pearlashes are about £23 per ton.
The casting-table was heated on the top by charcoal, at an expense of £500 per annum.	The casting-table is heated underneath by cylinders, at scarcely any expense.
An engine of 32-horse power ground and polished (12 hours to the day) from 800 to 1,000 feet per week.	An engine of 60-horse power will grind and polish at least 3,600 feet per week.
A grinding-bench ground 200 to 250 feet per week.	A grinding bench at —— Works grinds about 500 feet per week. A grinding-bench may be constructed to grind 600 feet per week.
A polishing-bench polished, 200 to 250 feet per week.	A polishing bench at —— Works polishes about 500 feet per week. A polishing-bench can be constructed to polish better and cheaper, nearly 1,000 feet per week.
A plate-glasswork in London manufactured about 60,000 feet per annum	A company near London is making 8,000 feet per week, or more than 400,000 feet per annum. And that is insufficient, but they can make no more, having no room to extend.
The price of rough and moulded plate varied from 5s. to 6s. per foot.	The price of rough plate (¼ and ½ of an inch thick) is 1s. 6d. to 2s. per foot; (cost 10d. to 1s. per foot.) And one company has an order for 43,000 feet!
Wages were comparatively low.	Wages are high, but they do not amount to so much per foot as in 1827.
Large plates were made with great difficulty, and the cost on the average is estimated at about 10s. per foot.	The largest plates are made with perfect facility, at less than 3s. per foot. And this amount may be still further reduced to about 2s. 6d. per foot.
The manufactures kept a very large stock on hand.	None of the houses can keep stock, but can only supply their customers from hand to mouth, and that very inadequately.

Summary—Average.—In 1827 Plate Glass sold for about 12s. per foot, to the extent of about 5,000 feet per week.
In 1836 Plate Glass sold for from 8s. to 9s. per foot, to the extent of about 7,000 feet per week.
In 1844 Plate Glass sold for from 6s. to 7s. per foot, to the extent of about 23,000 feet per week.
In 1846 Plate Glass sells for 5s. to 6s. per foot, to the extent of about 40,000 feet per week.
May 30.—Now nearly 45,000 feet per week—(Exclusive of foreign glass.)

Looking at the extraordinary increase that has taken place, notwithstanding the severity of excise restrictions, and seeing that the demand now progresses more rapidly than ever, even at 5s. to 6s. per foot,—if the price were reduced to 4s. or 3s. 6d. per foot (which, free as the trade now is from excise interference, would afford ample profit), what must then be the demand?

TRIAL OF MAIL STEAMERS.

The Lords Commissioners of the Admiralty, having ordered a comparative trial to be made, to ascertain the speed of three new boats, recently built for service as mail packets, on the Dover station, the trial was made, and the following is given from impartial persons who were present during the whole time:—

"*Dover, May* 31.

"A most extraordinary trial of speed took place yesterday, between three of Her Majesty's steam-packets—Garland, Onyx, and Violet—the former being of wood, and designed by Mr. O. W. Lang, jun., assistant to the Master-shipwright at Chatham Dockyard (son of Mr. Lang, Master-shipwright at Woolwich Dockyard), and built by Messrs. Fletcher and Sons, of Limehouse; and the two latter well-known iron-boats, the fastest ever built, by Messrs. Ditchburn and Mare, of Blackwall; the dimensions of the vessels being the same, and the engines also of equal power, by Messrs. Penn and Co., of Greenwich.

"The Garland, under the able command of Captain Smithett, and the Onyx, Lieutenant-Commander Mudge, left Dover at 7 o'clock, a.m., the latter having the mail and passengers for Ostend, Captain Mercer, R.N., Superintendent of Her Majesty's packets on this station, being ordered by the Admiralty for this purpose on board the Garland.

"Off Dunkirk these two vessels were met by the Violet, Captain Sherlock, who came out of Ostend to meet them and to return with the others. At this time, about 10 o'clock, the Garland had gone by and distanced the Onyx about a mile and a half.

"The great trial of strength then was to beat the Violet, and although there was a decided superiority in this vessel over the Onyx, the Garland in less than three-quarters of an hour was far enough ahead of the Violet to be able to cross her bowes. After this a second trial was made, the Violet altered her trim, but in this the Garland showed a still greater superiority; and in a third trial it was conclusive that the Garland could beat Violet about one-third of a mile an hour, and Onyx half a mile an hour, which has established the fact that the 'Wooden Walls of Old England' are not to be beaten by any other material or power, and we ought to congratulate ourselves and the country on the fact.

"The Garland returned from Ostend to Dover this day in 3 hours 55 minutes, which is by far the quickest ever known, and has established her reputation as being the fastest steamer in England.

"The Garland also fell in with the Queen of the Belgians, the fastest of the South-Eastern Ramsgate steamers, and went round her in less than a quarter of an hour."

THE NEW LOCOMOTIVE ENGINE "THE GREAT WESTERN."

On June 13th an experimental trip was made on the Great Western, from London to Bristol and back, for the purpose of trying the tractive powers of the new monster engine "The Great Western." The train weighed 100 tons, and consisted of ten first-class carriages, seven of which were ballasted with iron, the other three being occupied by the directors and those interested in the experiment.

The train started from Paddington at 11 hour 47 min. 52 sec. It passed the 1st mile-post at 11 hour 51 min. 1 sec., and came abreast of the 52nd mile (immediately after which the breaks were put on for the stoppage at Didcot), at 12 hour 45 min. 24 sec., running, therefore, the 51 miles, with a rise of 118 feet, in a few seconds over 54 minutes, or at an average speed of upwards of 56 miles per hour.

At Didcot a stoppage of 5 min. 15 sec. took place. The mile-post beyond Didcot, viz. the 54th, was passed at 12 hour 54 min. 27 sec., and the 75th mile-post (just after passing which the breaks were put on for the stoppage at Swindon) was reached at 1 hour 18 min. 6 sec., the distance of 21 miles having been passed over in 23 min. 39 sec., or at the average rate of upwards of 54 miles an hour.

At Swindon there was a stoppage of 4 min. 27 sec. The 78th mile-post was passed at 1 hour 29 min. 30 sec., and the 98th mile-post, which is a short distance on the Paddington side of the Box Tunnel, was reached at 1 hour 49 min. 26 sec., the 20 miles having therefore been accomplished in 19 min. 56 sec., or at upwards of a mile per minute. The train came abreast of the 117th mile-post at 2 hour 12 min. 3 sec. This gives the time occupied in running the distance between the 78th and 117th as 42 min. 33 sec. for the 39 miles, or something like 53 miles per hour.

The maximum speed on the down journey was obtained between the 83rd and 92 mile-posts. From the 80th to the 84th mile there is a falling gradient of 8 feet per mile, and from the 85¾th to about the 86½th mile there is a falling gradient of about 1 in 100, and a fall of 8 feet per mile then reaches to about the 90½ mile-post; a rising gradient of 8 feet per mile then succeeds, and extends beyond the 122nd mile-post. The train came abreast of the 83rd mile-post at 1 hour 34 min. 56 sec., and passed the 92nd mile-post at 1 hour 43 min. 8 sec., performing the 10 miles in 9 min. and 8 sec., or at an average speed of nearly 66 miles per hour. The 87th and 88th miles, on a falling gradient of 8 feet per mile, were run over at the rate of *sixty-nine* miles per hour.

The train arrived at Bristol about 15 min. past 2, thereby making the time occupied in starting from a state of rest to coming to a state of rest, or, in other words, from platform to platform, 2 hours 26 min., including stoppages, which averages a rate of 50 miles per hour.

At Bristol, a collation awaited the invited guests, Mr. C. Russell, M.P., in the chair. In the course of his speech took occasion to remark that a greater speed *might* have been attained, had not one of the pumps for supplying the boiler with water given way shortly after passing Slough, to remedy which they were under the necessity of reducing the pressure in the boilers. The train afterwards returned to London. Mr. Brunel drove the engine both ways.

The principal dimensions of this great locomotive are—Cylinders, 18 in. diam. and 2 ft. stroke; driving wheels, 8 ft. diam.; supporting wheels, 4 ft. 6 in. diam.; has six wheels and uncoupled; 278 tubes, 9 ft. long and 2 in. diam.; fire-box outside, 5 ft. 6 in. by 6 ft.; inside, 4 ft. 10 in. by 5 ft. 4 in., with a partition through the middle, giving 160 ft. of heating surface, and 20 fts for area of fire-grate; total heating surface, 1,750 ft.; from level of rail to top of cylindrical part of boiler, 9 ft. 6 in.; and from level of rail to top of chimney, 14 ft. 8 in.; supporting wheels 16 ft. apart, with the driving wheels in the centre; total length of engine, 24 ft.; tender on six wheels; weight of engine, 30 tons; tender, 15 tons.

The following statement of the time kept between London and Bristol taken from the *Times* slightly differs from the preceding statement, which is given on the authority of the *Railway Chronicle*.

	h. m. s.		h. m. s.		h. m. s.
Paddington	11 51 50	40th „	12 35 55	74th „	1 20 47
1st mile	11 54 0	41st „	12 37 3	75th „	1 21 50
2nd „	11 55 25	42nd „	12 38 10	76th „	1 22 57
3rd „	11 56 40	43rd „	12 39 15	Swindon	1 24 40
4th „	11 57 41	44th „	12 40 21	Started again	1 29 6
5th „	11 58 48	45th „	12 41 2	78th mile	1 32 15
6th „	11 59 51	46th „	12 42 34	79th „	1 33 35
7th „	12 0 57	47th „	12 43 40	80th „	1 34 43
8th „	12 1 55	48th „	12 44 43	81st „	1 35 43
9th „	12 2 56	49th „	12 45 55	82nd „	1 36 43
10th „	12 3 58	50th „	12 47 4	83rd „	1 37 40
11th „	12 4 59	Didcot	12 50 10	84th „	1 38 35
12th „	12 5 58	Started again	12 55 25	85th „	1 39 9
13th „	12 6 56	53rd mile	12 56 10	86th „	1 40 24
14th „	12 7 55	54th „	12 58 15	87th „	1 41 15
15th „	12 8 52	55th „	12 59 40	88ht „	1 42 11
16th „	12 9 49	56th „	1 0 48	89th „	1 43 7
17th „	12 10 48	57th „	1 2 4	90th „	1 43 57
18th „	12 11 46	58th „	1 3 9	91st „	1 44 56
19 h „	12 12 45	59th „	1 4 15	92nd „	1 45 51
20th „	12 13 45	60th „	1 5 21	93rd „	1 46 48
21st „	12 14 46	61st „	1 6 26	94th „	1 47 48
22nd „	12 15 46	62nd „	1 7 32	96th „	1 50 0
Maidenhead	12 16 48	63rd „	1 8 38	97th „	1 51 7
Twyford	12 25 40	64th „	1 9 46	98th „	1 52 6
82nd mile	12 26 0	65th „	1 10 55	101st „	1 55 55
33rd „	12 27 10	66th „	1 12 0	102nd „	1 56 56
34th „	12 28 18	67th „	1 13 7	103rd „	1 58 0
Reading	12 30 10	68th „	1 14 16	104th „	1 59 4
35th „	12 30 29	69th „	1 15 19	105th „	2 0 8
36th „	12 31 33	70th „	1 16 22	106th „	2 1 20
37th „	12 32 37	71st „	1 17 27	118th „	2 15 12
38th „	12 33 41	72nd „	1 18 32	Bristol	2 16 [illegible]
39th „	12 34 47	73rd „	1 19 38	Time occupied	2 25 41

*** The results of this experiment are deemed by the advocates of the broad gauge to settle the controversy in their favour, or, as Mr. Russell, M.P., chairman of the company, expressed it with more emphasis than elegance, "to put an end to the 'humbug' of the narrow gauge." With great deference, however, it may be submitted that this is not quite correct. The observation, that the engine would have gone faster if one of the pumps had not broken, seems a rather innocent one; for that "if" contains the whole gist of the matter. They never get up any astonishing performances on the Great Western Railway without one of these casualties occurring. We are constantly told of the wonderful feats of the express trains, but those who are accustomed to travel by this railway are always on the look out for some accident especially, which, if it do not involve loss of life and limb, causes a detention. There is always "a screw loose somewhere," or if it be not loose at starting, it works loose during the journey.

Now what is wanted in an important *commercial* agent such as the Great Western or the Birmingham Railway, is not a few showy results now and then, but constant uniformity and punctuality—not an excessive speed, but one which may be thoroughly depended upon. Until, therefore, the Great Western Company can work their engines at these high velocities for *months* together, and pass over the points and crossings at the intermediate stations, without accident, they will not have proved their point.

We offer no opinion here as to the superiority of either gauge; it seems to us that too many opinions have been offered already. As far as we can judge, the best railway gauge, if we had to begin *de novo*, would be one of intermediate width, but whether excess or deficiency of width be the greatest evil we cannot decide; of neither gauge have the powers been yet sufficiently developed to render it possible to pronounce an authoritative opinion. However, this is certain, that the diversity of gauge has at least one beneficial result; it stimulates the rival engineers to exert themselves to the utmost.

ROMAN REMAINS AT COLCHESTER.

The fifth number of the Journal of the British Archæological Association contains a description of some remarkable specimens of Roman art, discovered at Colchester. Among them was a sphynx, sculptured in stone, found in the garden of the General Hospital, about ten paces from the west wall, and about fifty-five paces from the London Road, at two feet from the surface of the soil: close to it was dug up a fragment of the tibia of a human leg, bones of oxen, deer, pigs, and fowls, with Roman pottery; and between twenty and thirty paces from the same spot, part of a sepulchral inscription to the memory of one or more legionary soldiers. Within the bounds of the hospital were dug up at the same time a large quantity of building materials, red and white tiles, coarse and unhewn stones, used probably in foundations, and a great many well-hewn fragments of a stone called swanage, from a place in the Isle of Purbeck, where it is chiefly dug; the fragment of the inscription above alluded to is of the same material. The stone in which the sphynx is sculptured is freestone, brought probably from Portland. Very recently, Mr. Taylor, the resident surgeon, has noticed, in the same locality, a Roman wall, from four to five feet wide, and from ten to twenty feet in length, as far as it was excavated. A bronze statuette of a sphynx, about an inch and a half high, was found in 1820, within a few yards of the stone figure. As a work of art, the sculptured sphynx exhibits a good taste and executive skill of no mean order. The fabled monster of Thebes, combining the five-fold attributes of a virgin, a lion, a bird, a dog, and a serpent, is correctly exhibited in accordance with the ancient myths in which it figures so conspicuously. The head, breasts, and arms, are those of a beautiful virgin; the fore-paws are of a lion; the body and fecund dugs indicate a bitch; the hinder part takes the lion's form; and the tail, doubled upon itself in short foldings, is the serpent in repose. The mangled remains of a human being lie beneath the figure, and protrude on both sides. The head of the victim is extremely well executed; the eyelids are closed; the mouth is drawn down at the corners; muscles are strained and set, and the countenance, sunk in death, conveys an expression of exhaustion and agony. Altogether, the composition is good and harmonious, and is probably of early date. On the base is cut a large S, doubtless a mark of the quarrier or of the sculptor.

In the collection of Mrs. Mills, of Lexden Park, is a bronze figure of Cupid riding on a sea-griffin, discovered some years since in excavating for laying the foundations of Colchester bank, but which has been hitherto unpublished. The god of love is often represented riding on the back of a lion, or on dolphins and sea-monsters, emblematical of his omnipotence, which is well symbolised in the triform griffin, a combination of bird, beast, and fish, obedient and tractable under the gentle sway of the youthful divinity.

AUST PASSAGE BRIDGE.

Sir—With respect to Mr. Fulljames's letter on the subject of the Aust Passage Bridge, I beg to state that in the paper published with the names of Mr. Giles and myself in your April number, there was no claim to originality in the proposition to build a bridge across the Old Passage of the Bristol Channel at Chepstow, the idea having been originally suggested by Mr. Telford many years since. A mere reference to the map will at once point out the Aust Passage as the narrowest part of the channel in that neighbourhood. The occurrence of rocks, visible at low water and suitable for the foundation of piers, is a still further recommendation of that locality for a suspension bridge.

The span of the bridge at Freiburg is 820 feet, and Telford proposed one of 1,000 feet at Runcorn. There is no doubt that this could be constructed so far as the mere strength of the main chains is concerned, but the liability to undulation is a very serious obstacle. I see no reason to alter the opinion already expressed that the plan which I have been anxious to lay before the public, would completely remedy that defect, which has proved very injurious to the most celebrated of our suspension bridges in exposed situations. I believe that a bridge with radial bars would, if properly constructed, be quite capable of allowing the passage of railway trains, and that opinion is confirmed by considering the strength which lattice bridges have by actual experience been found to possess.

The form of the suspension bridge proposed by me was first published in Weale's Quarterly Papers for Lady-day, 1845, and I there gave an outline of the design, which was afterwards described in a more complete form in your Journal, for a bridge over the Aust Passage.

Mr. Fulljames appears to intimate some intention of commenting upon my calculations. I shall feel very much obliged to him for pointing out *all the errors* which he is able to detect.

I am, Sir,
Your obedient servant,
Francis Bashforth.

REVIEWS.

Studies of Ancient Domestic Architecture, *with observations on the Application of Ancient Architecture to the Pictorial Composition of Modern Edifices.* By Edward Buckton Lamb, architect. Twenty Plates, 4to. London, Weale. 1846.

A book that comes with a quotation from Candidus for the motto on its title-page, brings with it, as may be supposed, a letter of recommendation to us, nor has the prepossession in its favour, so caused, been at all deceived. Mr. Lamb—whose name has repeatedly been mentioned by us for praise in our notices of the architectural drawings in the Royal Academy's exhibitions—has here produced an exceedingly clever work, replete with original remark and sound instruction. In the generality of architectural publications in which engravings constitute the leading and foremost feature, the letter-press is either of very subordinate quality—little better than mere filling-up stuff, or anything but architectural—sometimes evidently the compilation of some book-maker, who besides pillaging not only his matter, but entire paragraphs verbatim from others, does not seem to have even so much as looked at the plates to which he was writing. Such is not the case here, for, though all the subjects represent actual examples of ancient—that is, Old English-domestic architecture, instead of cramming his pages with gossip history about the houses themselves and the people (all their kindred included) by whom they have been occupied, Mr. Lamb leaves those readers who have a taste for such "information" to seek it in professedly topographical works, contenting himself with speaking of the respective subjects, "exclusively with reference to artistic criticism elucidated by direct example." Criticism of that kind—especially so good of its kind as what we here obtain—is rather a scarce article; at least, it is very rarely served up to the general public, who are kept upon a water-gruel diet of discussion about "styles" alone; as if people needed to have such *incipient* information to be dinned into them on every occasion, and needed no other instruction at all. A very great deal more, it may be suspected, is requisite for enabling them to make use of such "first-step" knowledge, when we find that even those who can show off very fluently, so long as they stick to styles and dates, either become quite mute in regard to anything further, or else betray that their *knowledge* is all got by rote, and does not reach beyond what just enables them to discriminate between one style and another, but leaves them incapable of judging of individual productions of the art, except as they happen to conform to or deviate from precedent. So strongly, indeed, is a blind and servile regard to Precedent now insisted upon, that nothing seems to be left for us to do in architecture but to copy literally what *has* been done; besides which, it might be thought that those who lived in former ages had so completely foreseen and anticipated all the wants of the present one and of our actual social condition, as to render any further modification of the styles we borrow from them wholly unnecessary—and not only unnecessary, but dangerous. If Precedent is to be so followed—not as a guide merely going before us on the road, but one on whose footmarks we must plant our own feet at every step,—we may as well renounce at once, both for ourselves and for architecture, the power of doing anything that has not been done before. Those who cautiously follow Precedent step by step generally hobble along though they may not stumble; yet better is it that some should stumble—perhaps, break their necks—than that a whole generation should go hobbling along, and perhaps, at last, get angry and shove Precedent aside, and fairly take their leave of him altogether.

We are not losing sight of Mr. Lamb all this while, for we are glad to find that he has not at all more respect for that same bugbear Precedent than ourselves. He too considers Precedent—that is, that "slavish adherence to it which paralyses all invention"—to be the "very rust of art—the canker that feeds upon its vitality." After all, too scrupulous a regard to precedeet affords not the slightest defence against bad taste in architecture and decoration, for, as is here observed, "the worst conceits of the Pompeian, the tawdriest crinkum-crankums of the Louis Quatorze style, are *facsimilized* by our decorators, as if the taste displayed in them were so pure and perfect, that to deviate from it would be profanity."—But let us begin at the beginning, *mon ami* Belier, and, *certes*, the opening paragraph of the volume is well penned, and serves as a very appropriate vestibule—to express ourselves architecturally—to what follows.

"At the time of its being re-introduced and adopted into modern practice, so very ill was our mediæval architecture understood, so great was the ignorance that prevailed even as to its very nature, constitution, and physiognomy, and so completely was even that ordinary sort of good taste which is founded upon good sense disregarded, that notwithstanding its evident and almost total unfitness for the purpose, the ecclesiastical style of former times was taken—or, to speak more correctly, mistaken—as one for imitation in modern residences, while our ancient Domestic architecture" (Mr. L. rejects the orthodox final *k* of the Camdenists in "Domestick") "—examples of which are, or were then at least, sufficiently numerous and varied, both in towns and in the country,—was overlooked altogether. Church windows—or something like church windows—spruced up and divested of all characteristic finish and detail, entitled a modern house to be called a Gothic mansion. In like manner, a line of battlements, and perhaps a turret or two besides, were deemed quite sufficient to constitute a very passable 'castellated style.' Then again, we had Gothic cottages—perhaps the race is not yet quite extinct—spruce little things, whose *Gothicism* lay in their having pointed-arch apertures for windows. In short, had it been intended to parody and burlesque our former styles of architecture, for the purpose of bringing them into contempt, hardly any better mode could have been devised."

This is most true; and not the least singular part of the matter is, that the most egregious parody and burlesque of all should have been perpetrated by one who not only set up for but actually was, and by some still is, looked upon as an accomplished antiquary and a profound authority in matters of taste; for in both the one character and the other, most completely does Strawberry Hill damn the credit of Horace Walpole. The Strawberry Hill humbug, however, is over; and, as Mr. Lamb says, "We can now laugh at such things as supremely ridiculous, although the laugh will not be joined in cordially by every one,—not by those who have had such flagrantly absurd taste entailed upon them by their immediate predecessors, and perhaps at an enormous expense. Even yet, however," he continues, "Ancient Domestic architecture is not sufficiently understood. In regard to certain individual features that serve as distinctive marks of buildings of that class, it may be allowed to be tolerably well understood at the present day; yet hardly is it so in its nature as a style—as one capable of expressing itself distinctly, decidedly, and without any affectation, even on ordinary occasions. In like manner, as there may be a great deal of aim at character by means of certain pretensious features, yet, after all, little of it in general composition, and just as little of artistic effect,—so may a very strong degree of character be kept up or produced where there is apparently scarcely anything to account for it. In art—and I would wish to assert such title for architecture—it is only what would be called a few trifling touches that frequently contribute all the difference between the masterly and the trivial. Unfortunately for architecture, it has not been considered necessary to teach more than elementary forms, without regard to their value and effect in combination; in other words, without regard to composition and character. It is true, the really *artistical* lies beyond the limits of the *teachable*, yet for that very reason ought students to be impressed with the necessity for striving to advance beyond mere rules—with the necessity for self thinking."

Now, confound the book! we go on transcribing and transcribing without knowing where to stop; and feel ourselves shrunk from a reviewer into a mere copyist. And, as if on purpose to vex us, what is said is so much to the purpose and so well expressed, that we cannot attempt to condense it without injuring it. We must, therefore, skip over a very great deal, and content ourselves with producing some of the passages which have most arrested our attention, or which are sufficiently intelligible in the separate form of extracts. The following is one of them:—

"The reproduction of ancient forms can never be the means of *continuing* the art as it was practised by those whom we affect to imitate by merely doing exactly as they did under widely different circumstances. The adoption of the improvements necessarily resulting from advancing refinement has ever influenced architecture. The whole history of the art, in our own country in particular, attests this. Almost every successive century produced some marked change—some one of those distinct modes which we designate *styles*, though all belonging to one general style. Be it especially observed, too, that such successive changes were always gradual and uniformly progressive: there was in those days no such thing as the *re-assumption* of any former style. Wherefore there is reason to believe, that had not an entirely new direction been given to architecture in the sixteenth century, the very latest Gothic or best Tudor might have been carried on much longer, and would have acquired fresh spirit and energy. We of the present day are, on the contrary, at once exceedingly strict, and exceedingly lax,—most bigotted in some respects, and most latitudinarian in others; for although shocked at the idea of presuming to treat any one style with artistic freedom, our taste is so pliant that it accommodates itself to nearly all styles alike, just as whim or fashion brings them by turns into vogue. For all the styles we possess we are entirely indebted to those who have gone before us, not even attempting to make any addition of our own to the general stock; whereas, by *continuing* the same spirit which marked the works of preceding ages, we should in a short time work out a style accommodated to our actual requirements, and at the same time marked by æsthetic quality."

Very different is this from—we need not say how much more rational and how much more cheering than—that doctrine which would convert art into mere mechanical routine, and which tacitly proclaims—(mark the bull!)—disbelief in the ability of architecture to do more than copy and repeat its former deeds and doings. It would seem that, though its hands may be as strong as ever, its intellects are impaired—its imagination completely gone; so that it has become not only prosaic, but a twaddler and proser at once boastful and desponding, and for ever and anon exclaiming "Oh! the days when I was young!" Not content with its keeping to one route, pedants and sticklers for precedent insist upon architecture being handcuffed and manacled also. If it presumes to put forth a finger or make a single movement of any kind that is not in conformity with their instructions, they stand aghast at its temerity and audacity. Yet surely there is nothing unreasonable in demanding that we should be allowed to *continue* any style which we have taken up, by modifying and adapting it to existing occasions and purposes. The right of such *continuation-process* has been claimed in Germany, where its good effects have shown themselves in several instances. That it has been uniformly attended with success we do not say; but for what style, we would ask,—let it be adhered to ever so slavishly,—can uniform success be insured? Some have gone astray, quite astray perhaps;—well, what then?—are we to have no more wine because some people get beastly drunk with it?—or "are we to have no more cakes and ale because *Sir Robert* is virtuous?" Let it also be carefully borne in mind that the ultimate efficacy of a *continuation-process* is not to be prejudged from its beginnings. It must have time to operate. A tree does not bear the desired fruit the very day after it has been engrafted. At any rate, those who do not care to venture upon any fresh ideas themselves, ought not to discourage others by "pooh-poohing" and sneering. To say the truth, their doing so betrays what they would most studiously of all conceal, namely, their apprehension not of failure for others, but of their success,—apprehension lest those who are more enterprising and possess more artistic stamina than themselves should get forward by leaping over the fence that bounds the beaten pathway.

It is easy enough, it will perhaps be objected, for any one to say that we *ought* to modify those styles belonging to former periods which we now make use of; the difficulty lies in the doing it. True: and to be reproached for not doing it might seem too much like an inconsiderate if not insolent taunt on the part of a mere writer on architecture, totally unpractised in design. Such a one speaks under the comfortable assurance that his own ability will never be put to the test; but the author of the present volume has shown that he is capable of acting up to his own doctrine, and that while treating a style freely, he can be truer to the spirit of it than many one who pique themselves upon copying from it literally, and can produce "certificate" for each separate part in their designs. There are buildings which cut a very brave figure in description, yet a very sorry one when beheld; for we then ofttimes find that the great something in words, turns out to be a nothing in reality, or at the best, something very feeble and poor. Nor is it in the treatment of style alone that Mr. Lamb shows *forte*, for he is generally exceedingly happy in composition; and on the subject of composition—certainly a very important one—he gives us some excellent remarks in this volume, and they are all the more welcome because scarcely anything of the kind is to be found in books that are otherwise professedly for architectural instruction. In continuation of the general remarks on composition, are others more specific, and in detail forming a connected commentary on the subjects shown in the plates, and which are thereby rendered *studies* in a double sense. In fact, the work altogether abounds with instructive lessons, and is one that deserves to be studied with attentive reflection as well as read; and that it will be read by all those who, if they can't buy, can steal or borrow it—(viz., steal by borrowing, the latter being the approved fashion of book-stealing)—we may venture to prophecy, unless we are altogether mistaken by attributing to the architectural public far greater relish for art than they feel. Although we cannot even pretend to prophecy as much, we would fain hope that this is only the precursor of other publications from the same quarter, for Mr. Lamb has opened a path for himself and entered upon a wide as well as an ungleaned field. At present, he has shown us only actual instances of Old English mansions and country-houses, but though they hold out excellent hints, and possess character and physiognomy, we now require to see some of those or else similar examples accommodated to modern ideas of comfort, and to modern refinements and modes of living. At any rate, he has rendered himself debtor to the public for a corresponding volume on the other division of Domestic Architecture, viz., that which relates to internal arrangement and design, furniture, perhaps, included,—a branch of his profession to which Mr. L. has directed his attention in a more than usual degree, as is attested by various contributions of his on the subject, in "Loudon's Encyclopædia of Cottage and Villa Architecture.

Horizontal Water Wheels, especially Turbines; their history, construction, and theory. By Moritz Ruhlman. *Edited by* Sir R. Kane. Dublin: Hodges and Smith, 1846; *small quarto;* pp. 76. *Six lithographic plates.*

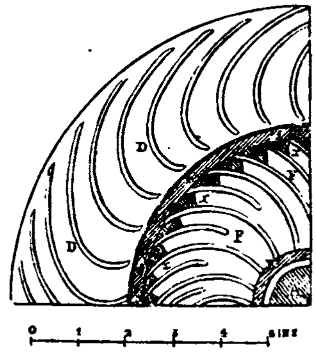
Notices of the construction and power of the turbines, or horizontal water-wheels, have appeared in this Journal in the volume for 1842, p. 265, and in the volume for 1844, p. 85 and p. 325. The publication of the work before us enables us to give some further information respecting the practical results obtained from these machines.

The present treatise is translated by the editor from the German, with the addition of some notes and an introduction. The translation was undertaken on account of numerous inquiries from millwrights and engineers, addressed to Sir Robert Kane, in consequence of his having directed attention to the turbine in his work on the "Industrial Resources of Ireland." He has selected for translation the present treatise by Professor Rühlman, as the most suitable for his purpose: at the same time he gives accounts of several other treatises on the same subject. From one of these, that by M. Morin, we take what we consider a very important extract, because it exhibits the general practical effects of turbines as determined, not from a doubtful theory, but from actual experience, and because these conclusions are confirmed by the authority of a commission consisting of MM. Arago, Prony, Gambey, and Savary, appointed by the Academie des Sciences to report on the subject. The following are the general results of the investigation:—

1. That the wheels are applicable equally to great and to small falls of water.
2. That they transmit a useful effect, equal to from 70 to 78 per cent. of the absolute total moving force.*
3. That they may work at very different velocities, above or below that corresponding to the maximum effect, without the useful effect varying materially from that maximum.
4. That they may work from one to two yards deep under water, without the proportion which the useful effect bears to the total force being sensibly diminished.
5. In consequence of the last preceding property, they utilize at all times the greatest possible proportion of power, as they may be placed below the lowest levels to which the water surface sinks.
6. That they may receive very variable quantities of water without the relation of the useful effect to the force expended being materially lessened.

Rühlman's treatise is divided into three parts—I., a history and description of the turbine; II., rules of construction; III., the mathematical theory. We shall confine our attention chiefly to the first of these sections, for the "rules" in the second section are derived from the "theory" in the third, which theory, whatever may be its value as a speculative inquiry, does not seem sufficiently well established to satisfy the wants of the practical mechanician. M. Rühlman's calculation of the useful effects of the turbine is founded on the principle of the Conservation of Vis Viva, and would perhaps be perfectly satisfactory if that principle held for fluids in motion. But it does not: the theoretical effect calculated from this principle is much greater than the effect really produced in practice; for it is found by actual experience that a large portion of the force of water in motion is absorbed by the mutual action of the molecules of water on each other, and by various resistances far too complicated for calculation. It is true that the results obtained theoretically may be modified by the introduction of "practice-coefficients:" but these coefficients, obtained from experiments on one kind of water machines, are not necessarily accurate when applied to another kind. Indeed, Sir R. Kane himself observes in his introduction, that "the action of the turbine, considered as a problem of hydrodynamics, involves conditions to the discussion of which science in its present state scarcely reaches." The value of the theoretical rules is therefore very doubtful. The most prudent course in this, as all other cases of practical mechanics where the theory is not fully settled, is to trust principally to experience, not neglecting, however, the *general* suggestions obtained from theory.

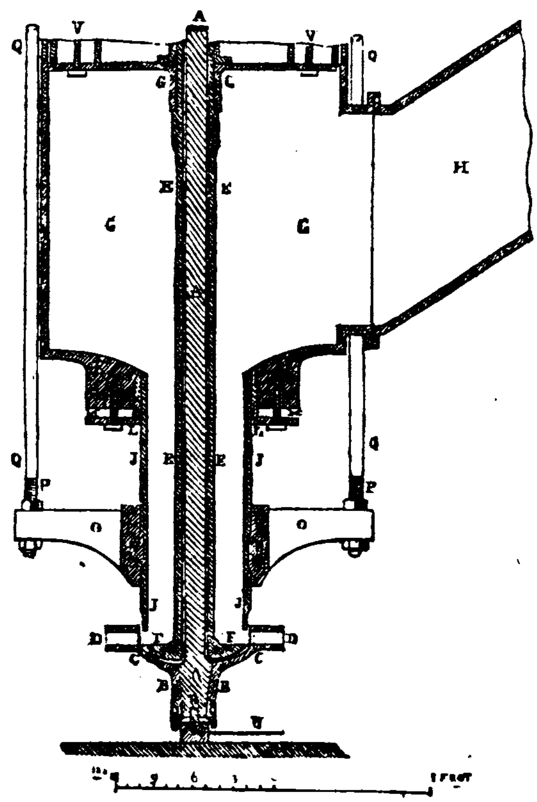
To proceed, however, to that portion of the present treatise which is of more direct interest, we observe that the general result of experience and of all that has been written on the subject tends to show that, of all the forms of the turbine hitherto invented, that by Fourneyron is by far the most useful, and to this, therefore, we may confine our attention. The following is a plan of a quadrant of a horizontal wheel erected on Fourneyron's principle in a cotton factory, at St. Blasien. The plan is drawn to a quarter the actual size.



In order to understand the action of the wheel, the reader must imagine the circles, of which the quarter only is drawn, completed. The machine will then be seen to consist of two parts—an inner wheel *fixed*, and an outer or larger wheel *revolving*. The water comes from the centre, proceeds along the guide curves F, F, which cause it to impinge directly upon the curved paddles D, D, attached to the outer wheel, which consequently revolves in the opposite direction to the impulse of the water.

The shaded parts *x, x*, are stops attached to a drum J J: the object of these stops is to shut off when requisite, the communication between the inner fixed wheel and the revolving one. J J is capable of being raised or lowered by external machinery, and consequently *x,x*, descending between the guide curves regulate the supply of water or shut it off altogether.

The next cut is a vertical section of the whole turbine, and shows the method in which the water is supplied to the revolving wheel.



* From Smeaton's experiments (Phil. Trans. 1759) it appears that in ordinary overshot water-wheels, nearly 80 per cent. of the original moving force is usefully applied; and that in undershot wheels, the useful effect is no more than 30 per cent. of the original power.—Ed. C.E. and A. Journal.

The water comes first from the supply-pipe H, into the cylinder G G, descends E E, and falls on the fixed guide-curves F, F; from these it rushes in horizontal streams against the paddles in the revolving-wheel D D, and finally escapes at the circumference D D.

The revolving wheel is connected by C C with a shaft B B, which turns on a pivot at its lower extremity. B B carries a main axle A A, which goes up through the water cylinder, and is applied to turn the machinery of the cotton factory.

J J, as has been explained, is the sluice which regulates the supply of water. The manner in which J J may be raised or lowered is easily seen from the diagram. The arms O, O contain matrices, in which the screws P, P work: these screws are at the ends of long rods Q, Q, turned by winches not shown in the diagram. It is clear that by turning Q, Q one way or the other, the sluice will be either raised or lowered.

L, K, M, show the means of packing J J to keep it water-tight.

U is a little conduit by which oil is conducted from a small reservoir to keep the pivot R constantly lubricated.

The main shaft and pivot are of steel, the wheel of wrought-iron, and all the other parts of cast iron. Though the wheel is only 12½ inches in diameter, it drives 8,000 water spindles, the roving frames, carding engines, and all the accessory machinery. The number of revolutions, with ¼ of an inch sluice opening, are 2,200 per minute. The available fall of water is 350 feet.

The following is Rühlman's account of his first impressions on examining this machine:—

The second turbine erected by the inventor at St. Blasien, with a fall of 117 yards, has become more important than any other. I can best describe this turbine by detailing what I myself saw and learned upon the spot during the journey already referred to. Already, half an hour before arriving at the remarkable locality of St. Blasien, situated in one of the most beautiful, but also of the wildest and loneliest parts of the Schwartzwald of Baden, a curious noise announces the uncommon spectacle, which becomes more extraordinary as you approach.

On entering into the wheel-room one learns there that what had been heard at a distance about this place was not merely mystification, but reality.

One then feels seized with astonishment, and wonders, more than in any other place, at the greatness of human ingenuity, which knows how to render subject to it the most fearful powers of Nature.

At every moment the powerful pressure appears likely to burst in pieces the little wheel, and the spiral masses of water issuing from it threaten to destroy the surrounding walls and buildings. Often when I went out of the wheel-room, and looked at the enormous height from which the conducting tubes bring down the water to the wheel, the idea forced itself upon me, "that it was impossible," but that idea passed away when I went back into the little room.

Fourneyron has here, for the first time, solved a problem, which will for ever render his name historical in the technical and scientific world, a problem in which he had to overcome not only the greatest obstacles of Nature, but also disfavour and prejudices in a thousand forms. Who could find any other means of utilizing this existing water power? Perhaps a water-pressure engine might be applied? Certainly not; since even without proving, by calculation, how little that kind of machine is suited for rotatory motion, it is only necessary to consider the very difficult and very power-destroying conversion of a vertical reciprocating motion into an uniform rotatory motion, in order to sufficiently appreciate the difficulties.

The conclusions arrived at respecting the general merits of the invention seem well worthy of attention, for they are expressed by an impartial witness, who has taken great pains to get at the truth.

It is certainly not true that turbines are capable of totally displacing vertical water-wheels, as was at first asserted. The greatest obstacles to the erection, construction, and working of turbines, at least in Germany, arise from the fact that many years must elapse before our millwrights will have acquired the necessary theoretical knowledge and practical experience. With these machines everything must be really calculated. It will not do to construct one wheel after the pattern of another, or to trust to what is called the practical shape. But also the construction of these wheels, in the workshop of the machine-maker, requires the greatest care, observation, and prudence, otherwise, no matter how it may be calculated, a good wheel cannot be produced.

It is now also fully admitted that Fourneyron deceived himself in supposing that these wheels economized 80 per cent. and more of the total available force. But the latest and fullest experience has shown that they economize certainly from 60 to 70 per cent., when those precautions are taken which should be attended to in their formation.

Finally, as to the choice between vertical wheels and turbines, in any particular case, it is decidedly to be considered that in every case where an overshot wheel, or a wheel with tolerably high breast, and what are termed overfall sluices, can be erected, such is to be preferred to the turbine; since the former, when carefully constructed, easily economizes more than 70 per cent. of the power. Yet in cases, as in cornmills, where the horizontal motion of the turbine may be immediately made use of, or where there is much back water to contend against, this assertion may require to be modified, since, as mentioned already, the turbine may be sunk to a considerable depth in the back water, without losing any material proportion of its power.

In every case of a fall, either higher or lower than that suitable for an overshot wheel, the turbine deserves decidedly the preference, and their not being erected in all such localities can only arise from want of knowledge, the apprehension of their being badly made, or of their cost being greater than that of the vertical wheel, which it should not really be.

The share which Sir Robert Kane has in this work as translator is by no means an unimportant one. He has reduced all the German and French measures to the English standard, and has interspersed the text with useful notes. His introduction is also valuable, for it directs the inquiries of those who require more information than that given in the present treatise, and his undertaking is, on the whole, a very valuable contribution to the literature of engineering.

The principal practical objection to the use of the turbine is, we believe, the difficulty of preventing the smaller parts of the machine from being stopped up by impurities in the water. The velocity with which the water is required to be discharged from the wheel renders it difficult to strain or filter the water sufficiently without impeding the current.

It may be useful to observe that in order that the full effect of the water may be obtained, it ought, when issuing from the circumference of the wheel, to be moving with the same linear velocity as the point from which it issues. For this is clear, that if the water be moving with *greater* velocity than the extremity of the channel between the paddles from which it issues, then, had the length of the channel been greater, the water would have continued to impinge on the paddles, and would have done more work. Again, if the water be moving at *less* velocity than its point of exit, it is obvious that, for some distance before the exit, the channel has been urging the water forward, instead of the water impelling the channel. But in the case where the velocities of the water and its point of exit are *equal*, neither acts on the other: the water no longer impels the channel, which shows that all the work is got out of it; and the channel does not urge the water, which shows that the motion is not impeded. This is the reason why turbines are made to revolve with so great velocity as that stated above.

Very similar reasoning will show that the end of the channel ought to be a tangent to the circumference of the wheel; for in that case neither does the water act on the wheel nor the wheel on the water at the point of exit; whereas, had the channel been more or less oblique, either the water must have been pressing on the paddles, or the paddles on the water, at the moment of issuing.

It may be useful to some of our readers to know that there is a model of Fourneyron's turbine in the model-room of the Museum of Economic Geology, in Craig's-court, Charing-cross—a museum little visited, because, we suppose, it is one of the most interesting in London, and is perfectly open to the public.

Weale's Quarterly Papers on Engineering, *for Christmas*, 1845; *part X., published June 1st*, 1846. Weale, pp. 204, 16 *Plates*.

The present part contains four papers: the first, a continuation of the "History of the Machinery and Manufactures of Great Britain," occupies 137 pages; the "Memoir on the Thames Tunnel," 29 pages; "an account of the Construction and Statistics of the Railway from Frankfort to Wisbaden," 27 pages with 15 plates; "a description of the proposed Wet Dock on the Wear at Sunderland," 11 pages, with one plate.

The first paper is devoted to the manufactures and improvements in machinery during the seventeenth century, and displays considerable antiquarian research. It contains, among other subjects of interest, an account of the efforts of Parliament to remedy the abuses arising from the royal privilege of granting patents. That wise and revered monarch, king James I., seems, to use a common phrase, to have made a good thing of his power of protecting inventors, for he frequently managed to share the profits, without bearing any part in the risk of the speculation. For example, in 1612 was granted "a patent to Simon Sturtevant for divers mechanic arts and mysteries of his own invention, whereby all kinds of metal workes........ now made after the ordinarie course with woodfuel and charcoal, may bee as well made and wroughte with sea coale, pit coale, earth coale, and brush fewel." The agreement was this—"the profits were to be divided into *thirty-three* parts, ten of which were to go to the King, five to Prince Henry, two to the Duke of York, and one to Viscount Rochester: the remaining *fifteen* shares were to be the property of the patentee, *who was to find all the money and run the whole risk.*" Fortunate Simon Sturtevant! The paper contains also a copy of the Marquis of Worcester's celebrated "Centurie of Inventions." The marquis must have been an extraordinary man, for, by his own account, he effected several physical impossibilities.

The continuation of the memoir of the Thames Tunnel follows. The account of the repeated discouraging failures to which Sir I. Brunel was subjected in the progress of his great work, and the courage with which he persevered, is very interesting. There are not, however, in the present number any of those admirable plates, representing the mechanical contrivance employed by Brunel in the Thames Tunnel, which rendered the former portions of this memoir of specific value to the engineer.

The letter-press description of the Frankfort and Wisbaden railway does not possess an interest commensurate with the excellence of the engravings by which it is illustrated, for the ground traversed by the railway is so level that there are few, if any, engineering works worthy of detailed description. We can speak from personal knowledge of the excellent regulations by which this railway is managed, and the convenience of dividing the passengers into *four classes*, all of whom travel much more cheaply than they would in England, and are seated in comfortable carriages defended from the weather and the smoke and hot cinders of the engine. In Germany, the comforts of the poor are less *talked* about than in England, but we are not certain that they are less attended to.

The new dock at Sunderland is designed by Mr Stephenson and Mr. Murray, and is to be 27 acres in extent. The following extract from the report of Mr. Walker, who was commissioned by the Lords of the Admiralty to examine the plan proposed, will explain the principal novelty in the design:—

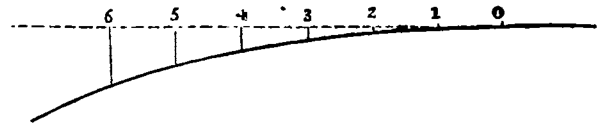
"The lift of a spring tide being only 14 feet 6 inches, the dock is to be 6 feet under low water, giving 20 feet 6 inches water in the dock on a spring, and 17 feet on a neap tide. The above depths can be maintained in the dock, but the depth at the bar at the harbour mouth is two feet less, so that with the "scud" of sea during a north-east gale a vessel drawing more than 14 feet cannot venture over the bar with safety. To have the dock so much deeper than the approach to it would be of little use, and yet, from the great draught of ships from foreign ports, it would be very advisable to have not less than 17 feet at neap and 20 at spring tides. The engineers propose to accomplish this by sending laden vessels chiefly out at the south end through a tidal basin of 4½ acres, with two openings, one having gates of 60 feet, and the other of 45 feet, between the dock and it and other similar gates between the basin and the outer entrance. The outer entrance or rather *exit* points south, south-east nearly,* and is to be formed by means of rough breakwaters, one on the east ride, nearly parallel with the entrance, and the other on the west side, nearly square with it. This southern passage is proposed to be as deep as the dock, and to kept to that level by *dredging* and *scouring*. The very important feature of the plan (the southern passage), is, so far as I remember, *new;* and if it can be effected as proposed, will be a great convenience, by giving laden ships two to four feet more water than can at present be depended on; starting them in the right direction for the south, when the wind is fair, also leaving the Wear or harbour entrance clear for the present harbour, and the entrance of light ships into the docks."

On Staking out Railway Curves. By George Heald. Carlisle, 1846. pp. 7.

This is a small lithographed pamphlet of seven pages, of which the extract given below will give a sufficiently correct idea. The author's plans of setting out curves seems correct; however the investigation does not require any wonderful amount of geometrical ingenuity, and we hope that the time is not far distant when every engineer and surveyor will know enough mathematics to solve so simple a problem for himself, without having recourse to books. This remark is however made without disparagement of the treatise before us.

The curve described in the following extract is strictly speaking a parabola—the curvature of a parabola near its vertex resembles that of a circle with sufficient accuracy for the purpose here proposed, if the offsets be small, and the radius of curvature very large.

"Having by the practice and examination of several methods of staking out railway curves arrived at the conclusion that it is best effected by employing the theodolite; and several friends having requested a detail of the system that I have pursued for that purpose. I have had the following summary of the principles lithographed for the information of those who may be desirous of becoming acquainted with the system. Suffice it to say as its recommendation that the system insures the curves being truly circular, and greatly economises the labour that is often requisite to drive the curve through a distant given point from which little or no variation can be allowed; which is a case of frequent occurrence, and upon some systems one whose practical execution is very tedious.



"The first principle is, that in circles of the magnitude of those used for railway curves, if a tangent be drawn to them, the offsets from the tangent to the curve increase according to the squares of their distances from the point of contact.

Thus let the junction of a curve and tangent be at 0; then, if equal distances be set off from 0 at the points 1, 2, 3, 4, 5, and 6, which may represent chains, the offset from the tangent to the curve at the 2nd, 3rd, 4th, 5th, and 6th will be respectively 4, 9, 16, 25, and 36 (or 2^2, 3^2, 4^2, 5^2, and 6^2) times the offset at the 1st chain.

"This is one of those close approximations which, though not rigidly correct as an abstract mathematical proposition, is much too near the truth to permit any discrepancy to appear after the most critical examination; it being understood that when the radius is as small as twenty chains, the length of the tangent is restricted to three chains, and when it is three miles radius it is restricted to eight chains, it is between these limits that railway curves are supposed to range.

"In the practical staking out of curves the offsets from the tangent to the circle at each chain length, expressed in inches, or feet and inches, are made use of, and from the preceding paragraph it will be seen that having the offset from the tangent for one chain length given, the succeeding chains will be deduced from it by multiplying by 4, 9, 16, 25, &c.

"It perhaps will not be amiss at this stage to point out a rule for finding these offsets, which is particularly convenient when the radius is some aliquot part of a mile, like the principle enunciated in section 2, to which it is so closely allied, it is practically correct, but not mathematically true. Its somewhat singular phraseology runs thus—from the square of the tangent in *chains* subtract its $\frac{1}{100}$th part; divide the remainder by the diameter of the circle in *miles*, and ten times the quotient is the required offset in *inches*.

A Treatise on the Steam Engine. By the Artizan Club. Parts XXIV. and XXV. Longman: 1846.

As these are the concluding parts of the treatise, we may as well say a few words respecting its general character, notwithstanding that the work has already been frequently noticed in these pages.

Excepting an excellent folio plate giving views of 14 of the most celebrated varieties of direct action marine engines, the present numbers contain little that possesses independent interest, for they are chiefly occupied by the index. We have however the introduction, by the editor, Mr. Bourne, and the character which he gives his own performance is on the whole so nearly correct, that we are content that it should be taken as an expression of our judgment on the work.

"The circumstance of having been published in monthly numbers furnishes, of itself, an explanation of many imperfections; for it can hardly be expected that works produced under the exigencies of periodical publication should be distinguished by the perfections which belong to literary leisure and fastidious elaboration. I have been obliged to confide the greater portion of the theoretical part of the present work to some mathematical assistants, whose algebra has, I fear sometimes risen to a needless luxuriance, and in whose superfine speculations the engineer may perhaps discern the hand of a tyro. In spite, however, of its imperfections I believe that the present Treatise on the Steam Engine is likely to prove the most useful yet published; and it is the only one, I believe, which can be regarded as of a really practical character. Although falling far short of my conceptions of what such a work should be, I believe that it substantially fulfils the promise held out in the prospectus; and having now collected the rough materials, I trust to be able, should another edition be called for, to clear them of the dross by which they are now disfigured, and present them in a form that will in some measure justify the public approbation.

"The preliminary and practical portions of the work have, for the most part, been executed by me, the disquisitions upon the slide valve and parallel motion are taken from the 'Artizan,' and other portions of the work are by various members of the Artizan fraternity. In the practical part of the work I have been able to obtain but little assistance from previous authors, and many of the subjects discussed are now brought for the first time before the public. Mr. Farey's work, though of great merit, gives but little information of any kind touching modern engines; and Tredgold's work is chiefly made up of mathematical sublimities, which have but little relation to practice."

The acknowledgement of the theoretical errors is made in a manner which disarms criticism. As far as we could judge the errors arose from an attempt to combine the theory of De Pambour with that of Tredgold—that is, the true with the false. We have no hesitation in saying that

* The bearings are all by compass.

Tredgold's theory of the steam engine bears the same relation to the truth which the speculations of the old Greek philosophers respecting planetary motion bore. The evaporative power of the boiler as an ingredient of numerical calculation is entirely neglected in Tredgold's theory, and the gross errors of principle with which his work is filled are made ten times worse by Mr. Woolhouse's profession of having corrected them. It is really too late, now that De Pambour's masterly investigations have been for six or seven years before the world, to endeavour to revive Tredgold's exploded views, and we regret that the treatise before us should have been injured by this injudicious attempt. However the reader is, we are very glad to find, put upon his guard in the preface, and it is therefore his own fault if he be deceived.

The great merit of the present work is the vast quantity of information which it affords as to details of construction. In this respect it seems unrivalled. The only thing to be complained of under this head is that a large amount of matter is frequently compressed into so small compass that the reader will often have a difficulty in finding the information for which he is in search. The book is not sufficiently digested—not systematic enough. It contains a vast store of invaluable facts, but these, like other warehoused commodities, are frequently so crowded together that it is difficult to get at them. Mr. Bourne talks of having a new edition; we hope that he may be encouraged to do so, and that he will adopt in it a simple and exact arrangement by which the reader may find "every thing in its place, and a place for every thing."

Hand Book of Mapping and Engineering Drawing. By B. P. Wilme. London: Weale, 1846, quarto. Part 6. Page 69.

This is the concluding part of a practical treatise on engineering drawing, which has been already favourably noticed by us. The present part contains a comparison of the different methods of copying maps, a description of drawing instruments, methods of representing geological strata, &c. There are some useful suggestions respecting the execution of Parliamentary Plans, which will be of interest to some of our readers, and may be quoted as a fair specimen of the character of the book.

"By the standing orders of the House of Commons, engineers and surveyors are required to plot their railway plans at a scale of not less than 20 chains to an inch. The width of railway surveys varies from 5 to 20 chains, at the option of the engineer. One very essential point to be attended to is to carefully survey, plot, and number all houses, fields, &c., within the *limits* of *deviation*. The *limits* of *deviation* are certain lines which mark the space beyond which it is not proposed to take power to deviate the line of railway. The limits of deviation are shown by a strong dotted line,—the proposed railway line is represented by a strong line.

"When railway plans are drawn at a scale of 20 chains to an inch, it is usual (compulsorily) to give enlarged plans of those subdivisions of land into very small allotments, as gardens, houses, &c., subdivisions being often rendered indistinct, from the smallness of the scale. The principal object of these enlarged plans is to enable the draughtsman to sufficiently develop the houses, &c., both by drawing and numbering; a separate number being required for each garden and house, as well as for all fields, roads, rivers, &c. The names of the different parishes through which the line is proposed to be carried must be written, and of late days the *county name* is placed at the top of each sheet. The sheets are numbered 1, 2, 3, &c., and the name of the line of railway is sometimes written over the number of the street, as Elverton, No. 1. The enlarged plan should be placed in each case directly over or under that portion of the small plan to which it refers. By taking care to get the portion of the railway line on each enlarged plan exactly parallel to the corresponding portion of railway line on the small plan, a very pleasing and convenient arrangement will be effected, and we are thus enabled in using the plan to find at once the enlarged portions. I have been induced to say so much for the guidance of the young surveyor, from having frequently noticed the slovenly manner in which some surveyors are in the habit of misplacing the enlarged plans. They are sometimes so jumbled together that it is quite a labour to wade through them. The radii of the curves in miles and furlongs is required to be written in each case where curves occur. When the plan is drawn at a scale of 20 chains to an inch, the enlarged plans are usually plotted at a scale of five chains to an inch.

The scale of six chains to an inch is one frequently adopted for Parliamentary railway plans; but they are seldom drawn to a larger scale than five chains to the inch. The relative merits of the large and small scales may be fairly taken as follows: viz., when the survey has been carefully taken, the scale cannot be too large; but if it be carelessly done, as is too frequently the case, it becomes necessary (as it is technically denominated) to *fudge* it, and in such cases it is frequently plotted or reduced to a 20 chain scale. This is done with a view to obscure, as much as possible, the inaccuracies of the survey. The merits of the large and small scales may also be taken in another light, viz., when there is a sufficiency of time to admit of plans being drawn at a large scale, it is desirable to use it, but if the time be short, the work will be sooner done at a small scale.

"Again, for the duplicate plans; this becomes a consideration. Lithographers charge a less sum for lithographing and printing plans at a small scale, than at a large one. Lithography has of late years become a very favourite medium with engineers and surveyors, for the production of duplicate plans for parliamentary deposit. It certainly has much to recommend it, and in proper hands, it would be a most invaluable medium. It is to be regretted that this art, (as applied to the purpose above named), almost essential to the surveyor, has fallen into the hands of an ignorant class of persons, viz., the picture-copiers and lithographic printers. It were impossible to detail the mischief annually done by persons being intrusted with this class of business, who are totally ignorant of the construction or use of maps. The numerous railway schemes brought before Parliament during the last two sessions have compelled engineers and other persons intrusted with the getting up of plans and sections to employ a miscellaneous collection of persons, who had never before been similarly engaged. A proportionate amount of mischief has been the consequence. It is painful to see even the professed picture-copiers or lithographic artists attempt to copy plans. The most ridiculous blunders are made, as might be expected; but of this no more. The remedy is simple; at least the evil may, to a great extent, be lessened, if not altogether removed. Let surveyors lithograph their own plans, or employ their draughtsmen upon them; much time and expense would thus be saved. The picture-copiers and lithographic artists would no longer have their brains addled with pursuits above their capacity; and the lithographic printers would have the plans put into their hands in a perfect state, instead of being obliged to send them back to the lithographic ignoramus for every alteration of his blunders required to be made by the engineer, on examining proofs. In fact, by the method recommended above, the necessity of proving may be in a great measure dispensed with.

"The principal point to be attended to in getting up such drawings is to draw them accurately. There is seldom time for pains-taking with embellishment, and the plainest style of execution is quite as useful as the most elaborately finished production."

The work is illustrated by excellent plates, and seems to convey detailed information on every point connected with the execution of architectural and engineering drawings.

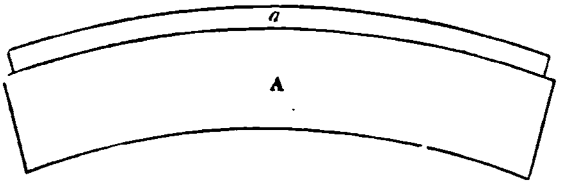
THEORY OF THE STRENGTH OF MATERIALS.

In our last number we published a paper on this subject, by our old correspondent Mr. Byrne, and as some of the arguments on which his views are founded, seem insufficient, we do not hesitate, notwithstanding our respect for Mr. Byrne's scientific attainments, to state where his opinion differs from our own.

The new theory proposed seems to be founded on the idea that there does not exist in deflected beams what is termed a *neutral line*. Now it appears to us that the existence of this line is capable of being proved by several methods which possess the strictness of mathematical demonstration. Before however, detailing these proofs, it may be as well to define what is meant by a neutral line, and to reply to the argument brought to disprove its existence.

The originators of the term "neutral line" stated that when a horizontal beam supports a transverse weight, the upper part of the beam exerts a thrust and the lower part a tension, and since these two portions of the beam exert opposite kinds of action, there must be in the beam some intermediate part which marks the transition from one state to the other—where, therefore, there is neither thrust nor tension. They asserted moreover that the actual position of this neutral line, or rather neutral boundary, depended on the dimensions of the beam, the degree of deflection and the weight supported; and their theory has hitherto been considered incontrovertible. Mr. Byrne however brings forward this argument against it—he says that if a beam be deflected and a slice be taken in the upper part of it (fig. 3, p. 164), this slice has the same form as the whole beam, and consequently there is as much reason for assigning a neutral line to the slice as to the whole beam. The consequent inference would be that the beam has an infinite number of neutral lines, but this absurdity is to be deduced, not from the original theory, but merely from Mr. Byrne's method of stating it. For when he says that the *form* of the thin upper slice is an argument for the existence of a neutral line in it, he makes the neutral line depend merely on the form of the beam and not on its mechanical action and the connection of its parts. If the slice *a* were actually cut off and separated from the remainder A, so as to have no connection with it, then when bent it would no doubt have a neutral line of its own. And if bent, as represented in the figure, while lying upon A, the lower side of *a* would not be so much extended as the upper side of A, but there would be some such difference as that in the diagram.

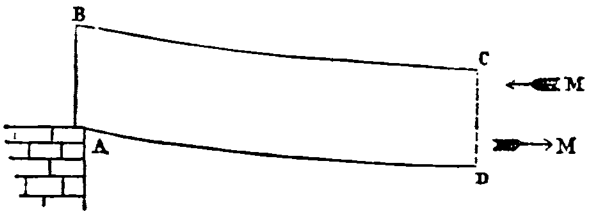
But in an undivided beam owing to the connection between its parts the portion *a* could not assume the form here represented. Its lower surface



must coincide with and be of the same length as the upper side of A, and be much more extended than when separated from it. Consequently no argument taken from the consideration of the slice *a*, in its separated state, will apply to it when considered as an integral portion of the beam.

We proceed now to the direct arguments establishing the actual existence of the neutral boundary.

Whatever may be the degree of deflection of a beam, and however great the load which it bears, it is clear that while the system is in a state of equilibrium, the internal forces of this beam and the external pressures upon it are subject to the ordinary principles of statics. Let A B C D be



one-half of a uniform beam resting on an abutment at A. Then if we suppose for simplicity that the beam is loaded uniformly throughout, the centre of gravity of the system is half way between the two abutments; that is, the pressures on each abutment are equal. Hence the pressure on A is the weight of A B C D, and the load on it. Or if R be the reaction at A, and W the weight of the beam and load together, $R = \frac{1}{2}W$.

Now if we suppose the beam actually cut in half at C D, it is certain that the equilibrium of A B C D will not be altered if we consider the molecular forces which the supplied by the connection with the other half of the beam to be external forces acting at C D. And whatever these forces may be, they are capable of being resolved parallel to three co-ordinate axes, and the resultants may be equated with the remaining forces of the system. Let the axis of *x* be parallel to the length of the beam and horizontal, let the axis of *y* be vertical, and that of *z* perpendicular to the two former. Then if $\Sigma(X)$, $\Sigma(Y)$, $\Sigma(Z)$ be the sums of the corresponding molecular forces we have equating all the forces of the system,

$$\Sigma(X) = 0, \quad \Sigma(Y) + R - \tfrac{1}{2}W = 0, \quad \Sigma(Z) = 0.$$

With respect to the second of these equations we have since $R - \frac{1}{2}W = 0$, $\Sigma(Y) = 0$, and since these forces represented by $\Sigma(Y)$ are all parallel and lie in one plane, they have a single resultant, and this resultant is zero, consequently there is no vertical force at C D. Similar reasoning applies to the forces represented by $\Sigma(Z)$.

With respect however to the longitudinal forces $\Sigma(X)$ the case is different; for these though parallel to each other do not lie all in one plane. Consequently they do not necessarily have a single resultant. The equation $\Sigma(X) = 0$ may be interpreted by supposing it to represent a couple $M, -M$; and if we take moments about A we shall see that this is the correct interpretation, for the moment of $\frac{1}{2}W$ about A must be balanced by some equal and opposite moment, and this can only be supplied by the forces $M, -M$.

The final conclusion is therefore that the resultants of all the molecular forces at C D are two equal and opposite forces $M, -M$, such that if the distance of the centre of gravity of A B C D from A be called *a*, and the distance between the points of application of M and $-M$ at C D be called *b*,

$$M\,b = \tfrac{1}{2}W\,a.$$

It is certain also from the direction in which M acts that it arises from the compression or tendency to compress the upper part of C D, and in the same way $-M$ arises from the extension or tendency to extend the lower part of C D.

We have therefore the upper and lower parts of C D in opposite states of action, and these two portions must be perfectly distinct from each other. It is quite impossible to conceive that the compressed and extended parts can *alternate*, that as we examine successive portion of C D, we shall have first an extended part, then a compressed part, then again an extended part, and so on. The portion of the beam exerting thrust cannot contain any part in a state of tension, and the portion exerting tension cannot contain any part exerting a thrust. Neither can these two portions *overlie* each other, for then we must have some part of the beam exerting both tension and thrust, which is as absurd as to suppose a man can pull and push a thing at one and the same time.

It is clear then that the two parts of the beam in opposite states of action are perfectly distinct from each other, and there must therefore be some boundary which marks the transition from the one state to the other, some place where the one kind of force ceases and the other begins. This place is called the neutral boundary.

It will be observed that this conclusion is deduced from foundamental principles of statics and not from hypotheses respecting the molecular structures of the beam which, however ingenious, are seldom trustworthy. It is a necessary consequence of the existence of a neutral line that the compression of the upper side and the tension of the lower should vary in degree, and gradually diminish towards the neutral boundary, so that there should be no abrupt transition from one state of action to another. It is impossible to imagine that the molecular action can *suddenly* change in any part: from the connection between each two successive laminæ, it is clear that the extension or compression of the one must be affected by the extension or compression of the other. We are therefore perfectly safe in supposing that there is some general law by which these variations of action may be represented, this is, that the amount of molecular force at any point of either side of the beam is a *continuous function* of the distance from some fixed point. Now this function changes its sign in passing through the neutral boundary, for on the upper side of the beam it represents forces contrary in direction to those on the lower side, and therefore, since no continuous function can change its sign without passing through zero or infinity, and since in the present case it is obvious that it cannot pass through infinity, it must pass through zero, and consequently there is no longitudinal action whatever at the neutral boundary.

It is usual to represent the molecular forces as a function of their distances from the neutral boundary. This is perfectly arbitrary and merely corresponds to a convenient choice of co-ordinates, for by properly altering the form of the function we might make the molecular forces depend on their distances from any *other* point of reference.

The determination of the actual position of the neutral boundary may frequently be difficult, but the fact of its existence does not depend on the labour of calculating its place. It fortunately happens however that for the cases which most commonly occur in practice—those in which the deflection of the beam is small —the place of the neutral boundary can be ascertained with quite sufficient accuracy to answer all useful purposes.

It may be as well to point out to those not familiar with the subject that this neutral boundary is not a mere matter of curious speculation, but one of direct practical importance. Every thing depends upon it. Without we know its position, we cannot tell how much of the beam is in a state of compression, and how much in a state of tension—in other words, *we can know nothing about the strength of the beam.*

We have wished to confine attention here to those things only which may be strictly deduced from the fundamental principles of mechanics, an which cannot be controverted without attacking those principles. We therefore do not enter into the consideration of the *form* of the function above alluded to. The assumption usually made accords perfectly well with the results of practice, and there does not seem the least reason for disputing its accuracy. At the same time we must remember that its correctness depends on experiment, and not on independent reasons. When, indeed the beam is perfectly homogeneous, there are good theoretical reasons in favour of the usual assumption, and of this at least we are certain, from both theory and experiment, that the true law must be so near the assumed one, that any error introduced into the calculation by this assumption will be inappreciable in the general result when the deflection of the beam is small.

We have stated our objections fully and freely, because if any mistaken conclusion be here set forth, Mr. Byrne will be able to correct them. If in error, we shall be sincerely obliged to him for setting us right, for we have no other object but the advancement of the truth; but till he does this, we shall confide little on a theory of the strength of beams founded on a denial of the existence of a neutral boundary.

MAGNETIC EXPERIMENTS ON METALS, ALLOYS, AND METALLIC SALTS.

A paper on this subject was lately read by Mr. William Sturgeon, at the *Manchester Literary and Philosophical Society*. After having taken a retrospective view of the labours of other experimentalists in this department of magnetics, the author proceeded to describe a novel apparatus by means of which his own experiments had been made. It consists principally of a powerful magnet and a light wooden lever, delicately suspended by a few silken fibres, the whole being enclosed in a glass case. By means of this apparatus, Mr. S. has found that gold, silver, copper, platinum, antimony, bismuth, lead, tin, and some other metals, when pure, are perfectly neutral to the action of the magnet, but that when some of them are combined they become magnetic in an eminent degree. Some of his earliest experiments, especially those on brass, many specimens of which he found to be magnetic, led him to suppose that their magnetic actions were due to small portions of iron which they contained; for in some of the metals of commerce on which he experimented, iron was absolutely present. In a mass of bismuth, for instance, iron was found in considerable proportions. Mr. S. has discovered that all our silver coinage is magnetic, but in different degrees, according to the dates of its production. Domestic articles of silver, as spoons, &c., are still more magnetic than silver coins. Gold coins are also magnetic, but not so highly as silver ones. The gold of articles of jewellery is more magnetic than gold coins. Mr. S. was still of opinion that these alloys might possibly contain iron, and their magnetism be therefore dependent on that metal, although he had met with some facts which he could not reconcile to that view. Having found much more magnetism in an old half-crown piece of William and Mary than in any other coin, and the historical report being that the silver coinage of that period was in a very base state, he supposed it possible that the high magnetic action of the old half-crown might be due to the extra proportion of copper, which led him to form an alloy of pure silver and pure copper, in which the latter metal formed about one-sixth part of the whole; and what is very remarkable, this alloy was more highly magnetic than any silver article he had previously examined. The copper and silver of this alloy had previously been ascertained to be non-magnetic; they were melted in an earthen crucible, and no iron entered the alloy. This fact, and some others which he subsequently discovered, shook the opinion Mr. Sturgeon had first formed respecting the pre ence of iron in brass, and the other alloys which showed magnetic action. Cavallo had discovered the magnetism of brass, and showed that hammered brass was never more magnetic than when unhammered, which facts corresponded to Mr. Sturgeon's own observations. But the most capital discovery had yet to be made. Mr. S. formed an alloy of iron and zinc in equal parts, and, to his surprise, found that this alloy was almost neutral to the magnet; so much so, that it would not move a magnetic needle at half an inch from the pole. In another alloy of those metals, the iron being about one-eighth of the zinc, magnetism was quite extinct. These novel facts naturally led to the inference, that as zinc is an essential constituent of brass, the magnetism of that alloy could not be owing to its containing iron; and subsequent experiments, both magnetic and chemical, have shown that this is the fact. Antimony has long been known to deteriorate the magnetism of iron, but Mr. S. has ascertained that its neutralising powers are much inferior to those of zinc. An alloy of antimony and iron, in which the latter metal was less than a twentieth part, still showed magnetic action, though in a slight degree. Mr. S. had also discovered that nickel loses all its magnetic powers when alloyed with about ten times its weight of zinc. Antimony also counteracts the magnetism of nickel, but not so powerfully as zinc. German silver, which contains a large proportion of nickel, is slightly magnetic; but in the inferior kinds of this alloy, where nickel is less abundant, no magnetism is perceptible. The neutralising metal in these cases is zinc.

The salts of iron which have been examined are mostly magnetic; but what is remarkable, their magnetism bears no proportion to the proportions of iron they contain. In conforming his theoretical views to the facts thus developed, Mr. S. now considers all bodies to be more or less magnetic, and classes them into two grand divisions—those that are palpably magnetic, and those that are but obscurely magnetic. The former class he calls *sapho-magnetics*, and the latter *asapho magnetics*.

Sapho magnetics are again divided into *mono-magnetics* and *suno-magnetics*, accordingly as they consist of individual or compound bodies respectively. Those bodies which counteract the magnetism of others, Mr. S. calls *katalo-magnetics*, because many of them, if not all, have the power of completely neutralising even the highest powers of *mono-magnetic* bodies.

The *mono magnetics* at present known are iron and nickel, and perhaps cobalt. In the class *suno magnetics*, Mr. S. places alloys of silver and copper, gold and copper, and zinc and copper, under the expectation that many more will soon be added to their number. The *katalo-magnetics* are very numerous, being all those that deteriorate the magnetism of other bodies. Amongst the metallic *katalo-magnetics*, Mr. S. has found zinc, antimony, tin, and lead. Other *katalo magnetics* are sulphur, oxygen, chlorine, cyanogen, and the generality of those bodies which combine with metals.

RAILWAY STATISTICS.

The annual return of the Board of Trade, recently published, contains some very valuable information on the subject of railway statistics. The following information is taken in a condensed form from that return:—

The total number of passengers, as given in the returns for the year ending 30th June, 1844, and for the year ending 30th June, 1845—

	1844.	1845.
1st class	4,875,332½	5,474,163
2nd class	12,23[illegible].686	14,325,825
3rd class	8,588,085½	13,135,820
Mixed	2,069,495½	8 5,445½
	27,763,602½	33,791,253½

The rate of increase of travelling in each class is—

1st class	12 per cent.
2nd class	17 per cent.
3rd class is upwards of . . .	50 per cent.

The amount received for each class is as follows:—

	1843-4.	1844-5.
1st class . . .	£1,432.688	£1,516,805
2nd class . . .	1,375.679	1,598,115
3rd class . . .	483,069	651,903
Mixed . . .	147,858	209,518
Total . .	£3,439,294	£3,976,341

The increase of returns on the year 1844-5 was, therefore, upwards of half a million on passenger traffic alone. On gross receipts from all sources it stood thus:—

1843-4	£5,074,674
1844-5	6,209,714
Increase . .	1,135,040

The rate of fares on the lines included in the above returns, and the reductions in the two years, stand thus at the end of the year 1845:—

	1845 Express. d.	1845 1st Class. d.	1845 2nd Class. d.	1845 3rd Class. d.	Reduction. 1st Class d.	Reduction. 2nd Class d.	Reduction. 3rd Class d.
Great Western . .	3·00	2·74	1 60	1·			
London and Birmingham	2·88	2·45	1·81	1·	·74	·32	·48
Grand Junction . .	2·44	2·08	1·71	1·	·92	·41	·39
Midland . . .		3·21	2 19	1·			·41
Birmingham and Gloucester		3·16	2·37	1·			
Chester and Birkenhead.		2·00	1·60	1·			
Great North of England.	3·46	2 93	2·13	1·	·53	·26	·60
Hull and Selby . .		1·93	1·54	·967			
Lancaster and Preston .		3 30	2 10	1·			
Leeds and Selby . .		2·06	2·00	1·			
Brighton . . .	2 97	2·37	1·78	1·18	·47	·11	
Croydon . . .		1·42	1·14	·85			
South Western . .	2·87	2·48	1·91		·70	·42	·26
Manchester and Birmingham	2·47	2·11	1·62	1·	1·12	·77	
Manchester and Leeds .		2·28	2·00	1·	·94	·23	·41
Newcastle and Darlington	3·23	3·07	2·15	1·	·15	·30	·38
Newcastle and Carlisle .		2 40	1·80	1·			
North Union . .		2 45	1·63	1·	·54	·51	·38
Preston and Wyre .		2 52	1·59	1·			
South Eastern . .	2 45	2·04	1·36	·82	·48	·28	·10
York and North Midland		3·00	2·25	1·	·50	·25	1·00

Cattle, Sheep, &c.—The total number of cattle conveyed in the year 1844-5 is nearly two millions. The gross amounts received range as follows:—

London and Birmingham . . .	£50,000
Great Western	17,000
Midland, and Bristol and Birmingham .	9,000
Eastern Counties	5,300
South Western	4,000
Manchester and Leeds . . .	4,000
York and North Midland . . .	3,200
Great North of England . . .	3,200

Horses.—The number conveyed is as follows:—

Bristol and Birmingham . . .	2,879
Chester and Birkenhead . . .	664
Eastern Counties . . .	2,160
Northern and Eastern	2,796
Grand Junction	4,267
Manchester and Birmingham . . .	785
Great North of England . . .	2,709
Great Western	10,504
London and Birmingham . . .	10,749
London and South Western . . .	5,570
London and South Eastern . . .	2,714
London and Brighton . . .	4,303
Manchester and Leeds . . .	1,409

Midlands	9,595
North Union	989
York and North Midland	4,197

Coal Traffic.—The following shows the gross tonnage and amounts received on the undermentioned lines in the year beginning 1st July, 1844, and ending 30th June, 1845:—

	Tons.	£
Arbroath and Forfar	12,000	1,700
Ardrossan	42,144	2 106
Ballochney	282,622	3,206
Bristol and Birmingham	70,000	3,708
Canterbury and Whitstable	13,000	1,188
Clarence	300,000	20,000
Dunfermline	28,477	3,142
Durham and Sunderland	372,714	22,712
Edinburgh and Dalkeith	118,340	4,800
Glasgow and Ayr	120,000	8,000
Glasgow and Garnkirk	1,761 000	7,600
Great North of England	181,012	13,079
Hartlepool	790,486	32,627
Hayle	20 000	2,400
Leicester and Swannington	178,566	15,827
Liverpool and Manchester	133,396	9,414
Llanelly and Llandilo	92,381	6,067
London and Croydon	6,000	500
London and South Eastern	22,519	
London and Brighton	30,000	2,400
London and South Western	4,000	
Manchester and Bury	49,826	3,332
Maryport and Carlisle	119,375	7,244
Midland	313,854	42,000
Newcastle and Carlisle	205,500	19,476
Newcastle and Darlington	400,000	
Newcastle and North Shields	26,936	1,198
North Union	321,923	
Pontop and South Shields	662,829	49,591
Preston and Wyre	21,538	4,289
St. Helens and Runcorn Gap	229,775	9,762
Sheffield and Manchester	58,668	2,447
Sheffield and Rotherham	16,000	977
Stockton and Darlington	900,000	80,000
Taff Vale	125,986	19,039
Ulster	807	130
Whitby and Pickering	1,708	241
Wishaw and Coltness	390,240	9,969
York and North Midland	47,529	2,419

Rate per mile for toll only, and for total charges:—

	Toll. d.	Total Charges. d.
Canterbury and Whitstable		6·00
Dunfermline and Charlestown		4·29
Bodmin and Wadebridge		4·25
Hayle		4·20
Dundee and Newtyle		3·37
Maryport and Carlisle	1·16	3·33
Arbroath and Forfar		3·30
Monkland and Kirkintilloch		3·00
South Western		3 00
Wishaw and Coltness	2·27	2·90
Manchester and Bury		2·30
London and Croydon	2·00	2·25
South Eastern		2·12
Brighton	·25	2·10
Newcastle and Carlisle		2·00
Leicester and Swannington		1·75
Llanelly and Llandilo	1·00	1·50
Bristol and Birmingham		1·43
Durham and Sunderland		1·40
St. Helens and Runcorn Gap		1·40
Pontop and South Shields	·75	1·30
Garnkirk and Glasgow		1·27
Newcastle and Darlington		1·25
Edinburgh and Dalkeith		1·25
Preston and Wyre		1·25
Taff Vale	·66	1·16
Manchester and Leeds	1·00	
Clarence		·91
Hartlepool	·75	
York and North Midland		·75
Great North of England		·50

The above are not in all cases the average charges, but the maximum charges; as on some lines, a higher rate is charged for going up hill than for going down hill.

VIBRATION OF TRAINS IN TUNNELS.

Report on the vibration produced by trains in passing through the tunnel of Kensal Green. To R. Stephenson, Esq.

Sir—I have the honour to submit to you the results of the series of experiments performed at Kensal Green, with the view of ascertaining to what distance the vibration produced by a train in passing through the tunnel may be sensible.

In these experiments, I employed a basin of quicksilver, which was placed on the ground and fixed as firmly as possible. A lens carrying a set of cross wires was attached, in such manner that the image of the wires could be reflected in the mercury, and therefore any vibration of the mercury could be easily detected by the oscillation of the reflected image. A piece of glass effectually protected the mercury from currents of wind, and the experiments were thereby rendered very satisfactory. In observing the reflected wires, I did not employ a telescope, as a previous trial had convinced me that no material advantage would arise from the use of a telescope, since the sensibility of the eye in detecting the least vibration of the mercury was far greater than I could have expected, and more than sufficiently delicate for the purpose in view.

The situation selected was a field belonging to Mr. Sullon, on the north side of the tunnel. The distances were measured with a land chain from the northern side, as nearly as its position could be ascertained.

April 16th.—The day cloudy, but without rain, a moderate breeze blowing from the eastward.

Distance 60 feet. Down train very great vibration, the reflected image of wires was quite invisible from agitation as the train approached the centre of the tunnel; the vibration commenced immediately the train entered the tunnel, and ceased the moment that it left.

Distance 138 feet. Down train—the vibration began about two seconds after the train entered, and ceased about the same time before it was out of the tunnel; though the amount of oscillation was much less than at 60 feet, it was still considerable.

Distance 300 feet. Down train—the vibration began immediately the train was in the tunnel, and continued about ten seconds after it had left; the train was in the tunnel twenty seconds.

Distance 472 feet. A heavy down train—thirty-two seconds in passing through the tunnel. The vibration was seen about seven seconds after it was in the tunnel, and ceased four seconds before it left. The amount was rather considerable.

Distance 572 feet. Up train—twenty seconds in tunnel. The oscillation of the mercury was sensible five seconds after the train entered, and ceased ten seconds before it emerged from the tunnel. Another up train produced the same effect.

Distance 644 feet. A down train—twenty seconds in the tunnel—produced *not the slightest effect.* The observation very satisfactory.

Distance 609 feet. A down train—twenty-seven seconds in the tunnel. The vibration so excessively small as to be visible only by transient glimpses when the train was fairly in the tunnel. *I consider this to be the distance where the vibration becomes sensible, and beyond it the trains will have no perceptible effect in this locality.*

The following estimated values for the *amount* of vibration, though necessarily very rude approximations, may still be interesting:—

Distance		Amount of vibration
Distance	60 feet.	100
,,	138	40
,,	300	25
,,	472	10
,,	572	5
,,	609	1
,,	644	0

On April 11th, some observations were attempted in a field adjoining that belonging to Mr. Sullon, at a distance from the tunnel of 400 feet, but the perpendicular drawing from the place of observation to the tunnel, would fall not more than 50 feet from the entrance, and this circumstance, in addition to most unfavourable weather, probably prevented my seeing any vibration. An objection being raised on this day against the performance of the experiments on Mr. Sullon's property, I was unable to proceed until the 15th, when that gentleman was kind enough to allow me the use of the field on the north side of the tunnel, a most favourable locality for the purpose.

On April 15th, I made some experiments to ascertain whether a horizontal wire of a transit telescope placed at different distances from the tunnel to bisect a distant object would show the vibration at those distances to be sensible. I very soon found that this method was not sufficiently delicate, as no vibration could be detected even at 60 feet distance from the side of the tunnel. The experiments with mercury on the following day were made under very favourable circumstances, and the results are, I believe, worthy of great confidence.

Mr. Bishop's Observatory, Regent's Park, J. R. Hind.
April 17, 1846.

EXTRACTION OF COPPER FROM ITS ORES BY ELECTRICITY.

The admirable researches of Becquerel upon the chemical actions effected under the influence of weak electrical currents, have opened a path destined to lead metallurgy to results of which we are even now unable to appreciate the full importance.

Having for their object the application of these actions to the extraction of copper from its ores, M. M. Dechaud and Goaltier De Claubry have long been engaged in researches which they now consider sufficiently matured to command attention, being destined to effect a complete tranformation of the existing processes. The following is a brief account of their results, reduced to the simplest form.

The extraction of copper from pyritous ores is divided into two series of operations entirely distinct, the roasting the ore, and the precipitation of the copper.

The Roasting.—This is effected in a reverberatory furnace, either by the direct conversion of the sulphuret into sulphate by the sole action of the air, or else by another reaction of useful application which consists in the transformation of the oxide of copper into sulphate by calcining it with sulphate of iron, at a dull red heat in a current of air, the iron being left in the state of peroxide.

Suitable washing extracts the sulphate of copper, which contains neither arsenic nor antimony, so that the most impure minerals, as the *fahlers*, will afford copper equally pure with the carbonates or oxides of copper which contain no other metal.

The Precipitation.—The precipitation of copper from its solution requires, in the galvano plastic processes, batteries of which the cost is far too great to be employed in metallurgy. It has therefore been attempted to obtain the same effect without the use of exterior batteries. The principle upon which the apparatus depends are these.

If we place, one over the other, two solutions, one of sulphate of copper, very dense, and the other of sulphate of iron, less dense, and in the first we place a plate of metal forming the cathode, and in the sulphate of iron a fragment of cast iron, and then unite these two metals by a conductor, the precipitation of copper commences at once, and is completed in a longer or shorter time according to the temperature, the concentration of the liquids, and the extent of the metallic surfaces. But as M. Becquerel has observed, the physical state of the copper undergoes great change as the liquid becomes weaker. We obviate this great difficulty by turning to profit the observation that after some minutes' action there exists four strata in the liquids; at the bottom we find the dense solution of sulph. copper, then a less dense solution of the same salt which has been deprived of its copper by precipitation; next is sulphate of iron become more dense by the solution of the cast-iron; and last, on the surface, the same salt in its original strength.

If, therefore, at the level of each of these strata we arrange suitable apertures for the addition or removal of the liquids in proportion as the chemical action goes on, we can easily preserve these liquids at uniform states of density, and thus the copper is always pure and in the same physical condition.

In the application of this process to metallurgy, the extent of surface of land required to precipitate a large quantity becomes an important consideration; it is, however, easy to modify the form of apparatus, though preserving the same principle, so as to avoid this objection.

With this object we arrange the liquids in vertical instead of horizontal layers; they are now to be separated by a diaphragm very permeable to electricity but not to liquids. Paste-board answers perfectly for this purpose; it lasts for months without undergoing any alteration, and the quantity of sulphate of iron which penetrates into the sulphate of copper is still too small to effect the operation. The apparatus is therefore arranged in the following manner:—

A chest of wood, lined with lead or some suitable mastic, contains the solution of sulphate of iron; through an opening near the top, we add the liquid until the proper degree of density is attained, while through a lower opening the saturated solution is allowed to escape.

Into this chest we plunge a number of cases, made of a frame having its ends and bottom formed of iron plate coated with lead; the sides are made of a sheet of paste-board. The strong solution of sulphate of copper enters through a pipe near the bottom, and escapes in its weak state through an opening at the top. *In* each case is placed a sheet of *leaded* iron; *between* each case, and outside the end ones, are plates of cast iron. Separate rods connect each plate with the common conductor which is supported above the apparatus. Two large reservoirs, of constant levels, receive the solutions and furnish them continuously. We adjust once for all the densities of the liquids, and then the apparatus works on for whole months without requiring any kind of attention. The most convenient strength of the solution of copper which escapes from the apparatus is from one-fourth to one-half of a saturated solution. The copper is precipitated on both sides of the sheet of metal forming the cathode.

As the paste-board prevents the *immediate* contact of the two liquids, we effect this by making small holes through its upper edge, taking care that they are some distance above the highest part of sheets of metal forming the cathode; the sulphate of iron can thus float above the solution of sulph. copper, and the vertical apparatus now fulfils all the conditions of the horizontal one.

At a temperature of 20 Cent. 68 F. one square metre (10·73 sq. ft.) of surface will receive as much as 1 kilogramme (15444 grs.) of copper in twenty four hours.

The precipitated copper is pure and is always in the same physical condition; the sheets obtained are fit for immediate working under the hammer, or to pass through the rolling mill; four or five passings through this gives the metal a density of 8·95; we therefore avoid all the operations required in the common process to reduce it from the form of bars to that of sheets. The manufacture presents no difficulties, requires no refining, and gives no scoria. In a regular manufacture as much as 75 per cent. of the copper has been obtained in the form of sheets, the remainder being precipitated, partly in pure fragments, and partly in powder of cementation. The authors consider, as a metallurgical result, at the lowest, 50 per cent. of the copper in sheets, 25 per cent. in fragments which only require fusion to be reduced into bars or plates; and 25 per cent. in powder requiring subsequent refining.

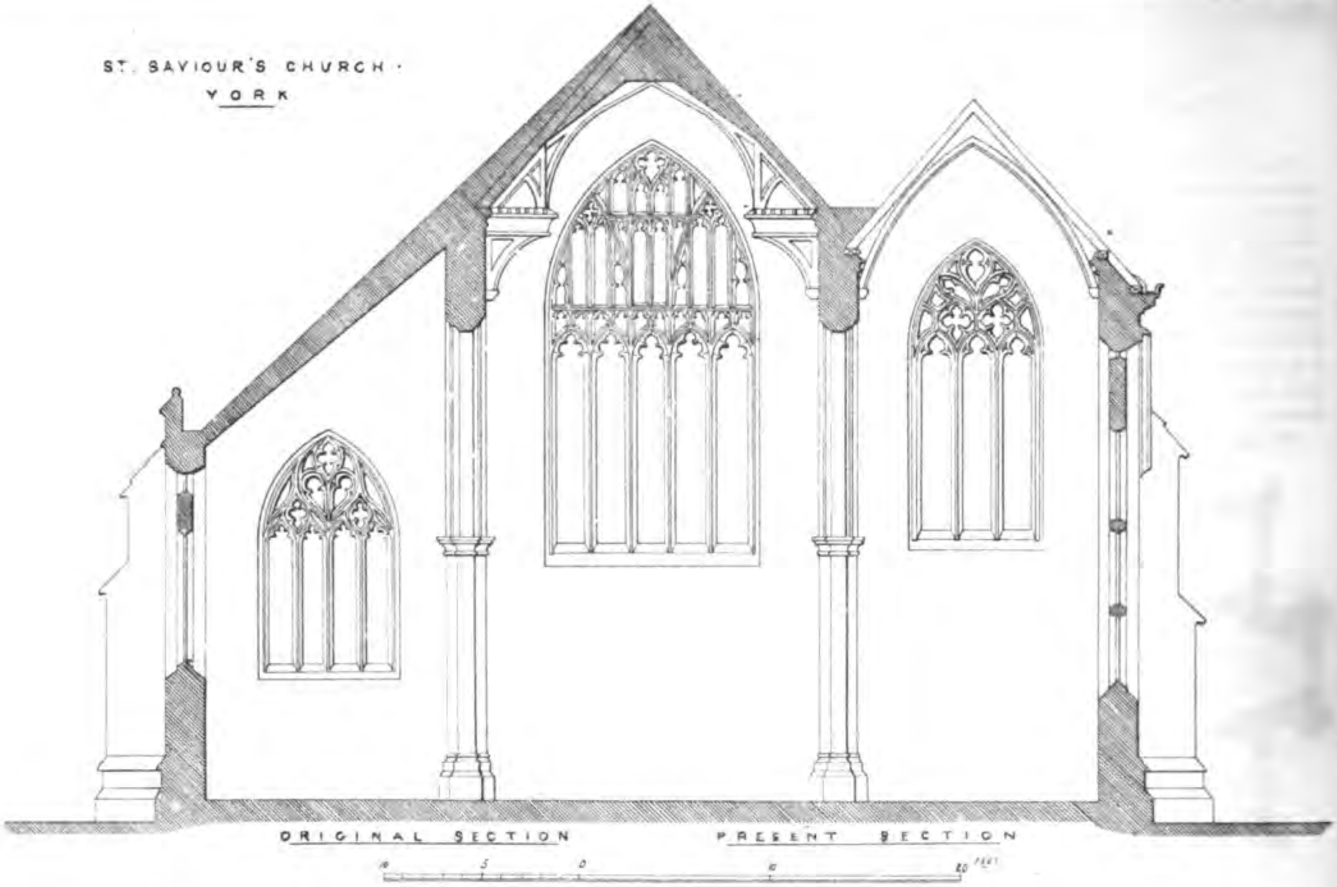
The question as to the applicability of galvanic action to the extraction of copper, appears to be reduced to the simplest possible form. It is hardly necessary to remark that electrotypes on the largest scale can be thus obtained.—*Journal of Franklin Institute.*

THE LEANING TOWER OF PISA.

"The moon was shining when we approached Pisa; and for a long time we could see, behind the wall, the leaning Tower, all awry in the uncertain light,—the shadowy original of the old pictures in school-books, setting forth 'The Wonders of the World.' Like most things connected in their first associations with school-books and school-times, it was too small. I felt it keenly. It was nothing like so high above the wall as I had hoped. It was another of the many deceptions practised by Mr. Harris, bookseller, at the corner of St. Paul's Churchyard, London. *His* Tower was a fiction, but this was reality—and, by comparison, a short reality. Still, it looked very well, and very strange; and was quite as much out of the perpendicular as Harris had represented it to be. The quiet air of Pisa too; the big guardhouse at the gate, with only two little soldiers in it; the streets, with scarcely any show of people in them; and the Arno, flowing quaintly through the centre of the town; were excellent. So, I bore no malice in my heart against Mr. Harris (remembering his good intentions), but forgave him, before dinner; and went out, full of confidence, to see the Tower, next morning. I might have known better; but, somehow, I had expected to see it casting its long shadow on a public street where people came and went all day. It was a surprise to me to find it in a grave retired place, apart from the general resort, and carpeted with smooth green turf. But, the group of buildings clustered on and about this verdant carpet—comprising the Tower, the Baptistery, the Cathedral, and the Church of the Campo Santo—is perhaps the most remarkable and beautiful in the whole world; and from being clustered there, together, away from the ordinary transactions and details of the town, they have a singularly venerable and impressive character. It is the architectural essence of a rich old city, with all its common life and common habitations pressed out, and filtered away. Sismondi compares the Tower to the usual pictorial representations, in children's books, of the Tower of Babel. It is a happy simile, and conveys a better idea of the building than chapters of laboured description. Nothing can exceed the grace and lightness of the structure; nothing can be more remarkable than its general appearance. In the course of the ascent to the top (which is by an easy staircase,) the inclination is not very apparent; but, at the summit, it becomes so; and gives one the sensation of being in a ship that has heeled over, through the action of an ebb-tide. The effect *upon the low side*, so to speak—looking over from the gallery, and seeing the shaft recede from its base—is very startling; and I saw a nervous traveller bold on to the Tower involuntarily, after glancing down, as if he had some idea of propping it up. The view within, from the ground—looking up, as through a slanted tube—is also very curious. It certainly inclines as much as the most sanguine tourist could desire. The natural impulse of ninety-nine people out of a hundred, who were about to recline upon the grass below it, to rest, and contemplate the adjacent buildings, would probably be not to take up their position under the leaning side, —it is so very much aslant."—*Dickens' Pictures from Italy.*

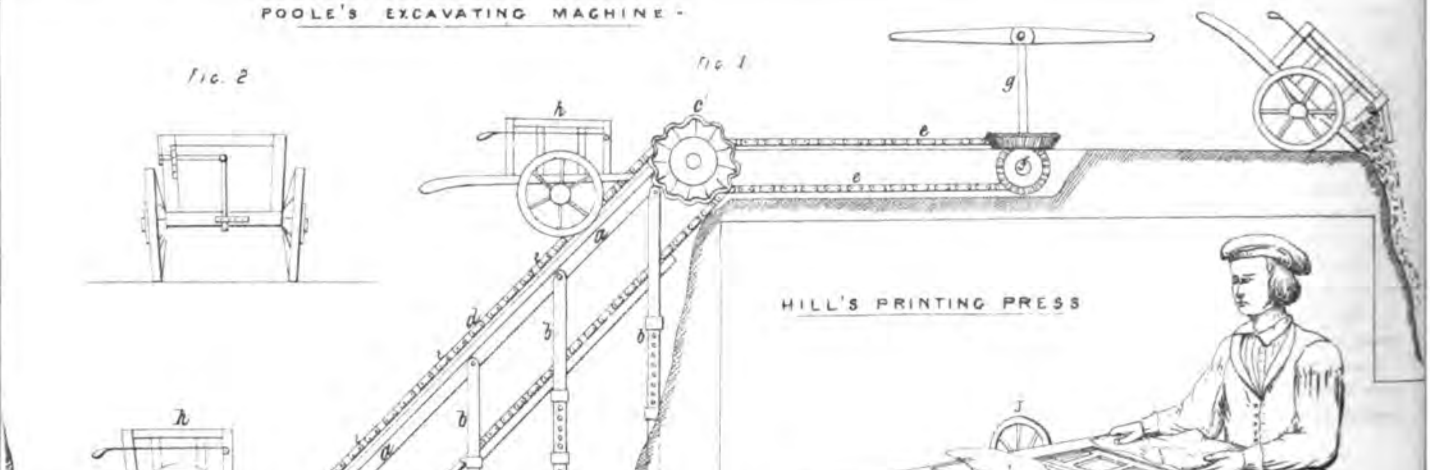
Steam Factory in America.—The central part of the Portsmouth steam factory, which is 204 feet long, is now two-thirds up. The centre part is to be six stories high, the wings five stories. Height of the lower story 13 feet, of the other stories 12 feet. The length of the front will be 504 feet, or about a tenth of a mile. There will be about four acres of flooring in the factory. Number of spindles, 50,000; number of operatives, 1,200 to 1,500. In the rear, two parallel buildings, two stories high, will be extended 100 feet back from the junction of the main building with the wings; and between those buildings, 50 feet from the main structure, the boiler-house is to be erected. The foundation of the chimney, which is to be 140 feet high, is laid, and is in progress of erection. A gentleman who has been travelling the last year in pursuit of information respecting manufacturing establishments, and who has visited more than a thousand factories, informs us that the largest factory building he has seen or heard of is at Manchester in this State, which is 440 feet in length. There is no factory in England to compare with it for size.—"American Paper."

ST. SAVIOUR'S CHURCH · YORK



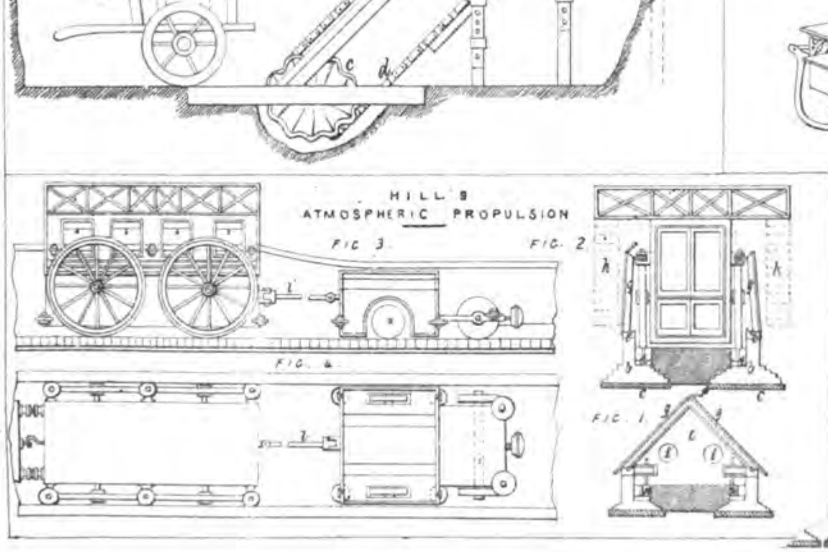
R. H. SHARP – ARCHT. —

POOLE'S EXCAVATING MACHINE ·



HILL'S PRINTING PRESS

HILL'S ATMOSPHERIC PROPULSION

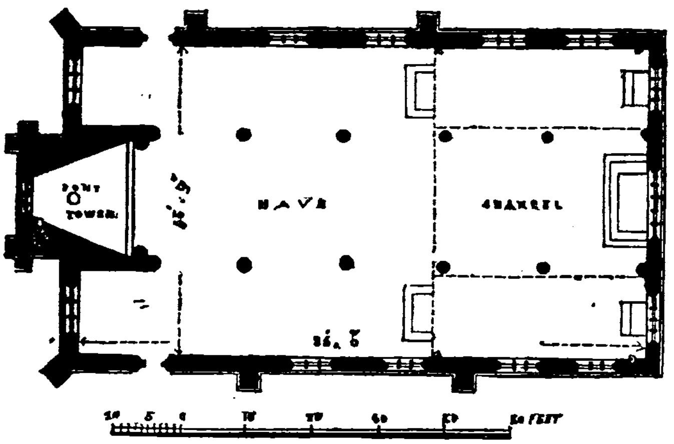


RESTORATION OF ST. SAVIOUR'S CHURCH, YORK.

(With an Engraving, Plate XI.)

The ruinous condition of this church having excited very serious apprehensions, a subscription was raised in 1843 under the patronage of the Archbishop of York, for the restoration of the decayed portions of the edifice. The work was assigned to Mr. Sharp, architect, who generously offered to superintend the restoration gratuitously. The church now affords accommodation for 1000 persons, of whom 423 have seats in the galleries. The report of the subscription committee expresses a regret that the funds raised did not suffice for the restoration of the tower and east wall of the chancel. A well-deserved compliment is also paid to Mr. Sharp for his liberal exertions, and the ability with which he has drawn up the report, which appears below.

The plan and section of the church here given are taken from drawings



sent by Mr. Sharp. We avail ourselves of his permission to print those portions of the letter sent with the drawings, which are of a public nature.

"Sir—Having received much gratification from able papers in your later numbers on Church Architecture, I am tempted to send you a "slip" of some observations I had occasion to offer to the Restoration Committee of one of our old churches in York, not so much from the importance of the work done, as that the opinions contained in the notes seem to harmonize with those of your talented correspondents . . . .

My only object in these communications is to answer the call that has been several times made on architects to supply notices of their works, and if I may be allowed to do so, to hint that letterpress of late usurps the place which we should all like to see filled with drawings.

After forty years study and practice of the profession of architecture, praise and censure are alike indifferent to me.

I send at the same time a carefully reduced plan and section of St. Saviour's church, the one side showing the former condition, and the other the present state. I am, Sir, with great respect,

Your obedient humble servant,

Richard Hey Sharp, Architect."

The total receipts and disbursements for the restoration amounted to £1300. At a meeting of subscribers recently held, it was agreed that a committee should be formed for considering the best method of presenting a testimonial to Mr. Sharp, in acknowledgment of his services.

The Architect's Report.

It would appear that the edifice lately restored was erected about the year 1420, at a time when the perpendicular style of Gothic architecture had superseded the decorated or flowery style. Traces, however, of this last remained in a beautiful four-light window, at the east end of the north aisle, which retained its painted glass. This circumstance prompted the retention of the flowery or undulatory style of tracery in the present eastern windows. Whatever merits the perpendicular style had over the earlier one, it is unquestionable that it was inferior in the adornment of the windows. A much earlier edifice, probably of the twelfth century, existed on the spot, the materials of which, including several gravestones, had been very unceremoniously employed in the walls of the later building. It is not unreasonable to suppose that the extreme badness of the foundation (the church is styled St. Saviour's in the Marsh) caused the premature ruin of the earlier building. Even in the later one, the south-west angle had sunk very considerably. On digging down to obtain a more secure foundation, the cause of the failure was plain enough. After passing through what appeared to be Roman rubbish, at the depth of 14 feet below the floor of the church, several rude coffins were found, which may not unreasonably be referred to a British æra: they were made of slabs of oak, 2½ inches thick, fastened by wooden pins or dowells, and contained skeletons in a very perfect state, but perfectly black from the infiltration of water from the bog in which they were laid. One of these coffins was directly across the angular buttress, so that there is no wonder that it should have sunk. The coffins were too much decayed to admit of removal, and the bones were laid in some of the vaults which the excavation had laid open. The usual methods of rubble foundation, now called concrete, were resorted to, and the corner is now perhaps more secure than the rest of the fabric. The eastern end of the church, as far as the chancel extended, had declined about eight inches, and it became a matter of urgent consideration with the architect, whether to take up the whole of this wall, and to refound it in the same manner; but as the settlement was of ancient occurrence, and did not appear to have increased of late, it was thought that the old foundation might be trusted to, and the more so as the new weight to be borne would not materially exceed the old one, which had been supported for so long a time without increase. The event has justified the opinion of the architect, as no settlement has become visible. As a measure of precaution, however, this half of the south wall was bound together by an iron tie-bar, ending in a stout anchor, which may be seen at the east end. A similar one is placed in the north wall, but the anchor is concealed within the buttress. These bars are connected with the large stones forming the window sills in what is thought to be a novel manner. What may be termed double lewises are inserted into the middle joints of the stone sills, and run with lead so as to connect them firmly together, the chain bars before mentioned are then secured by single or ordinary lewises. In this manner a powerful and permanent bond or connection is obtained. This detail is entered into, as the method may be useful in similar cases, or in new works.

A satisfactory foundation having been obtained, the main walls were carried up in a solid manner, and the windows inserted. This part of the work, and one of the most important, is executed in a very satisfactory manner, and is highly creditable to the contractor. The settlement before mentioned had extended to the arcades separating the aisles, which, when the plastering was removed, exposed cracks of an alarming character. Relying on the foregoing considerations, it was thought sufficient to wedge them up with solid oak, we believe from the Minster, and the result has been equally satisfactory. The paramount consideration of economy doubtless pressed on the architect's mind throughout all the operations. The next main point was the roof. It appears probable that the church had originally three roofs as at present, but at the time of important repairs, in the time of Charles 1st, the roof, whatever may have been its pristine form, was reduced to an uniform plane from the ridge to the eaves. In order to obtain this plane surface, the depth or thickness of the timbers was from 18 inches to 2 feet about half way up, the outer roof being separated from the lower and original one. The existence of several churches in York, All Saints, North-street, St. Sampson, and others, corroborates the notion of the triplicate roof. Indeed, so long as side galleries are demanded of the architect, this is perhaps the best form that can be given to a church, as it affords the requisite height to the side walls. It is to be hoped, however, that these abominable contrivances will either be abandoned, or that the Gothic style of building with which they are wholly irreconcileable, will be relinquished for the churches of Queen Anne, with which they are in perfect harmony.

Sufficient sound oak timber was obtained to frame the new roofs in a substantial manner; the old tiles were re-employed as more in character than slating, and as in lapse of time the defective tiles have perished, the remainder, although not very sightly, promise to endure for a very considerable period. An opportunity offered of procuring some excellent slates from the Minster, which were used in the inside roofs.

The main constructive points being obtained, the roof was lined with thin wood, the ribs intended to strengthen the roof added to the beams, which the safety of the church did not allow us to remove, and some ornamental work added.

In uncovering the old pews, which had been suffered to remain all this while, by reason of the uncertainty of obtaining the funds necessary for the repewing, a discovery of the original pews was made, and to the great gratification of the architect they were found to be almost identical with his design for the new ones, and for which the contract was made. It is not pretended that these fittings were the furniture of the church of 1400, or 1420. No doubt that edifice was prepared for the Roman Catholic service in a very different manner. Screens, or parcloses, doubtless then separated nearly one half the church from the people. The altar of the Saviour would occupy the eastern end of the nave, that of the Virgin Mary the end of the north, an of St. John Baptist of the south aisle. Near the second pillar from the east end screens, or reredos, would be placed across the aisles, against which stood altars belonging to the chantries, founded in the church by individuals. A piscina still remaining in the south walls confirms this opinion. Another, much defaced, existed in the north wall, and there were traces of others near the eastern walls. The particulars of these chantries are added below, but the business of the architect is not with them. The seven chantry priests presided over by the rector, would form a choir sufficiently numerous to occupy the middle chancel, and it would be for their use that the stalls, of which two have been preserved, were doubtless provided. Each of these priests had an equal endowment with the rector, and if these emoluments, properly reformed, had been continued to the church throughout the land, how different might the present state of things have been.

All these decorations had probably disappeared when, in the time of Charles I., the church was thoroughly repaired and fitted for the Protestant service. Many churches in York felt the benefit of similar, and as it often happens, simultaneous efforts. In St. Cuthbert's we have the date 1636 on pews of a character precisely similar, and others might be named. At that period York was often the residence of the Court, and would partake in the advantages of it. The architect decided that it was fruitless, with the extremely limited means at his disposal, to attempt any decorations of the fifteenth century, and that it was in better taste to adhere to the Protestant model of the first Charles. The lectern or reading desk now placed by the font is of this time. The font is of the time of the restoration, when the clergy exerted themselves, it has been said, with more zeal than taste to repair the ravages of the Puritans. The altar pieces of Belfry's, of St. Martin's, Coneystreet, and St. Martin's, Micklegate, are of this epoch, and, although out of place, are very handsome in themselves. The style, however, of the time preceding the rebellion retains enough of the Gothic character as not to shock the eye, and may therefore, it is conceived, be employed where circumstances forbid recourse to an infinitely more elaborate ornament. Of the fittings up of the Norman and early English styles we have in this country at least very scanty remains: the fifteenth century seems to have been the time of a general refurnishing, so to speak, of sacred edifices, in a manner more suitable to the greatly increased luxury and wealth of the age. In the more important edifices this change was not confined to the wood work; in Gloucester Cathedral the vaulting and pannelling are "spread like a network of embroidery over the old Norman work"

Before fixing the pews, precautions were taken to ensure dryness, and to prevent the ascent of noxious gases from the ground beneath. Means have since been employed to give sufficient warmth to the church.

It now only remains to the architect to acknowledge very thankfully the obligations he feels under to the restoration committee in general, and to the church-wardens in particular, for the great confidence they have been pleased to have in him during the progress of this tedious, and somewhat difficult work, without the succour of which trust his efforts would have been unequal to cope with the discouragements inseparable from such undertakings, where the funds are necessarily precarious.

It should have been noticed that considerable expense has been incurred in rebuilding the church-yard walls. The public spirit of the Improvement Commissioners came to the aid of the committee to carry out the very desirable object of insulating the church, and at the same time affording a double width to Hungate. A substantial wall and railing have been carried along St. Saviourgate and west end of the church, and although it is difficult in such matters to reconcile old ideas with modern ones, yet recourse has been had to Lincoln Minster for the pattern of the iron work. The external drainage of the church has been thoroughly completed. When it is remembered that the earth on three sides reached up to the place where the new works begins, about three feet above the floor, it is no wonder that damp and rottenness should have prevailed within.

To complete the perfect restoration of the church there remains only the tower, some parts of which are in a state of rapid decay. To remove the unsightly roof, to repair the mouldering stone work, to renew the dilapidated windows would be a most desirable thing, and after what has been done, it is surely worth an effort to accomplish it. Another work, hardly less desirable, is to remove the hideous vestry to a situation on the north side of the church, insulated from the church, but connected by a passage, where its being constructed in a plain manner would be of less importance; to renew the very beautiful eastern window, and so restore to this elevation its very handsome former appearance which has not, it is hoped, been injured by the elevation of the side aisles. Without having entered into a minute estimate, it is thought that £300 would suffice to carry out all these objects, and it is worthy of consideration by the benevolent persons who have already done so much to the restoration of an interesting and highly useful structure.

Richard Hey Sharp, Architect, York.

There were formerly no less than seven chantries belonging to this church, all of them of considerable value. The first was a very ancient chantry, founded at the altar of St. Mary, in this church, for the soul of Robert Verdenell, whose tomb-stone is under the present floor in the north aisle of the chancel. There was another chantry founded in this church, at the altar of St. John the Evangelist, for the souls of John de Hathelsey and Emma his wife. In 1468, this chantry was united to another chantry in the same church, founded for the souls of William Burton and Ivetta his wife, at the altar of St. James the Apostle and St. Lawrence. William Burton, of York, founded another chantry in this church, at the altar of St. Anne, for his soul and the soul of Ivetta his wife. There was another chantry founded in this church, at the altar of St. Thomas the martyr, for the soul of Adam de Spiriden; also one founded by Richard Watters, of great value; a chantry founded by William Frost, alderman, and Isabella his wife, in 1399; a chantry founded by William Gilliot. Besides these chantries there was also a gild or fraternity of St. Martin in this church, which was founded by letters patents from Henry VI.

DECISION OF THE BOARD OF TRADE ON THE GAUGE QUESTION.

The Minute of the Board of Trade, containing their lordships' deliverance on the Report of the Gauge Commissioners, is dated the 6th of June, 1846. It commences by stating that—

"My lords fully and entirely concur in the general conclusions at which the commissioners have arrived with respect to the advantages of uniformity of gauge for the conveyance of the internal traffic of the country. They are of opinion that the facts set forth in the report, and the evidence by which they are supported, incontestably establish the conclusion, that a 'break of gauge is a very serious evil,' and they see no reason to doubt the soundness of the opinion the commissioners have expressed, that none of the mechanical contrivances, or other methods proposed for mitigating the evil, 'are calculated to remedy, in any important degree, the inconveniences attending a break of gauge.'"

The Minute then quotes at length the conclusions and recommendations of the commissioners. The recommendations are in substance:—1st. That equitable means should be found of producing entire uniformity of gauge, by reducing the broad gauge lines to the narrow gauge. 2nd. That all public railways now under construction, or hereafter to be constructed in Great Britain, shall be formed on the narrow gauge. With respect to these proposals, the Minute remarks:—

"After long and anxious deliberation, my lords are unable altogether to concur with the commissioners in the full extent of these recommendations.

"Adverting to the vast expense which must be involved in an entire alteration of the broad gauge, and having regard to the circumstances under which the companies employing this gauge were established, and to the interests they have acquired, my lords cannot feel themselves justified in recommending that it should be proposed to parliament to compel the entire reduction of the 7 feet gauge. They feel, with the commissioners, that 'they cannot recommend the legislature to sanction such an expense from the public moneys, nor do they think that the companies to which the broad gauge railways belong can be called upon to incur such an expense themselves (having made all their works with the authority of parliament), nor even the more limited expense of laying down intermediate rails for narrow gauge traffic.

"Still less can they feel themselves justified in proposing that the expense of such alteration should be defrayed by a contribution levied, as has sometimes been suggested, on the rest of the railway companies in Great Britain: and they are unable to suggest any other equitable or practicable means by which the desired uniformity of gauge could be obtained.

"The conclusion to which my lords have come respecting the reduction of the broad gauge on existing lines necessarily affects their opinion with regard to the future gauge lines now in course of construction."

The Minute goes on to state that all that seems now possible is to prevent the further extension of the evils arising from different gauges, and reduce the inconvenience inflicted on goods and passenger traffic within the narrowest possible limits. To this end it is recommended that

"The lines for which acts have been obtained, but which have not yet been completed to the south of the line from London to Bristol, should be permitted to be constructed on the broad gauge, as originally intended. They have had some difficulty in coming to a conclusive opinion on the case of the South Wales line. They are aware that strong arguments may be adduced in favour of requiring this line to be constructed on the narrow gauge; but, adverting to the great public importance of a continuous line of communication with the south of Ireland, and of a second line of railway communication from Lonon to Ireland generally; and having regard to the value of a continuous line to Milford Haven, &c., for the furtherance of the public service; they are of opinion that, on the whole, it would be advisable that the South Wales line, together with its branch to Monmouth and Hereford, should, as originally sanctioned, be formed on the broad gauge."

The districts to which the Board of Trade has directed most of its attention are those which are to be supplied with railway accommodation by the Rugby and Oxford, and by the Oxford, Worcester, and Wolverhampton lines.

1. *Rugby and Oxford lines.*

"In the last session of parliament an act was obtained for forming a line of railway from Rugby to Oxford. The act contained the following clause:—

"'Cap. 188, sec. 35. That as a commission has been appointed for inquiring whether provision ought to be made for securing a uniform gauge in the construction of railways, and for other purposes in reference to the mode of obviating impediments to the internal traffic of the country; if, in conformity with the report of the said commission, it shall appear to the Board of Trade expedient that rails of the same gauge as the rails of the London and Birmingham Railway should be laid down on the line hereby authorised between Oxford and Rugby, it shall be lawful for the said board to order and require that such railway upon the said gauge shall be laid down and maintained, and that the company hereby incorporated shall thereupon proceed with reasonable despatch to execute the same to the satisfaction of the Inspector-General of Railways for the time being. Provided always, that nothing herein contained shall prevent the said company from laying down and maintaining, on the whole or any portion of the said line, rails of the same gauge as those now laid on the line of the Great Western Railway.'

"It is their lordships' intention, in the exercise of the powers granted to them by this clause, to require that the narrow gauge rails shall be laid down from Rugby to Oxford forthwith. They would, therefore, submit that it is not necessary to interfere with the construction of the line on the broad gauge, as authorised by the act. In order to complete the general chain of narrow gauge communication from the north of England to the southern coast, they beg to repeat with a slight variation the suggestion of the commissioners, that 'any suitable measure should be promoted to form a narrow gauge line from Oxford to Basingstoke,' or by any shorter route connecting the proposed Oxford and Rugby line with the South-Western Railway. With the same view they beg to suggest that any suitable measure should be promoted for forming a narrow gauge link from Gloucester to Bristol, and so completing the general chain of narrow gauge communication between the manufacturing districts, the centre and north of England, and the port of Bristol."

2. *Oxford, Worcester, and Wolverhampton line.*

"In the act by which the company was incorporated in last session the following clause was inserted:—

"'That the said company hereby incorporated shall, and they are hereby required to lay down and maintain upon the whole extent of the railway hereby authorised, between the point of junction thereof with the said Birmingham and Gloucester Railway at Abbotswood, and the point of junction thereof with the said Grand Junction Railway near Wolverhampton, as well as on the said branch railways by this act authorised to Kingswinford and Stoke Prior aforesaid, such additional rails, adapted to the gauge or the said Birmingham and Gloucester and Grand Junction Railways respectively, as may be requisite for allowing the free and uninterrupted passage, as aforesaid, of carriages, wagons, and trucks passing to or from the said Birmingham and Gloucester, and the said Grand Junction Railways respectively, or from the last-mentioned railway to the said Birmingham and Gloucester Railway, or passing from one portion of the said Birmingham and Gloucester Railway to another portion thereof, or to or from any intermediate place between the two said railways to the one or the other of them; and such additional rails shall be laid down, and maintained and used, to the satisfaction and approval of the Board of Trade, and all necessary facilities and accommodations shall be afforded by the company hereby incorporated, or their lessees, for the convenient use thereof; and it shall be lawful for the said board at any time, on complaint made by any company or person interested in the question that such additional rails have not been laid, or that such facilities or accommodations are not afforded, to order and direct the said company hereby incorporated, or their lessees as aforesaid, to adopt such regulations as they may see fit to require with reference to the laying down of such additional rails, or to the use of the said additional rails and other conveniences as aforesaid, and for the purpose of securing such free and uninterrupted passage thereon as aforesaid.'

"It is their lordships' intention to exercise the power given to them in this instance, as in the case of the Oxford and Rugby line; and on the same grounds they would submit that it is not necessary to interfere with the construction of this portion of the line on the broad gauge in the manner authorized by the act. And, since they regard the break of gauge as a most serious evil, more especially in the conveyance of goods, they conceive that a continuous and a second line of communication between London and the district of Staffordshire, &c., must be regarded as of great value and importance. They accordingly submit that the line from Worcester to Oxford should be made as proposed on the broad gauge. They regret that the provision for the formation of a second line of rails was not inserted in the act affecting the portion of the line between Oxford and Worcester, in the terms of the clause regulating the portion lying between the Birmingham and Gloucester line and Wolverhampton; and they would recommend, that if it should hereafter appear that there is a traffic requiring accommodation on the narrow gauge between the Staffordshire districts and the southern coasts, any suitable measure should be promoted by Parliament to form a narrow gauge link from the Birmingham and Gloucester line to Oxford, on the same grounds and in the same manner as the commissioners have recommended that it should be formed between Oxford and the South Western Railway."

The Board of Trade declines to give an opinion on the merits of the 4 feet 8½ inches gauge. They do not think that its adoption by the legislature as a national gauge—recommended by the commissioners—ought to be positive and final. They would leave an opening to adopt what may be recommended by the experience of Ireland or foreign countries.

"With this explanation, my lords beg to recommend, that no line shall hereafter be formed on any other than the 4 feet 8½ inches gauge, excepting lines to the south of the existing line from London to Bristol, and excepting small branch lines of a few miles in extent, joining the Great Western Railway, and conveying to it the traffic of places in its immediate vicinity; and they further recommend, that no bill for any such line as above excepted shall be passed by parliament, unless a special report shall have been made by the committee on the bill, setting forth the particular reason which have led the committee to advise that such line should be formed on any other than the 4 feet 8½ inches gauge. They concur, also with the commissioners in recommending that, unless by the consent of the legislature, it shall not be permitted to the directors of any railway company to alter the gauge of such railway."

The suggestions of the board, recapitulated in a condensed form at the close of the minute, are as follow:

"1. That no line shall hereafter be formed on any other than the 4 feet 8½ inches gauge, excepting lines to the south of the existing line from London to Bristol, and excepting small branches of a few miles in length, in immediate connection with the Great Western Railway; but that no such line, as above excepted, shall be sanctioned by Parliament unless a special report shall have been made by the committee on the bill, setting forth the reasons which have lead the committee to advise that such line should be formed on any other than the 4 feet 8½ inches gauge.

"2. That, unless by the consent of the legislature, it shall not be permitted to the directors of any railway company to alter the gauge of such railway.

"3. That, in order to complete the general chain of narrow gauge communication from the north of England to the southern coasts, and to the port of Bristol, any suitable measures should be promoted to form a narrow gauge link from Gloucester to Bristol, and also from Oxford to Basingstoke, or by any shorter route connecting the proposed Rugby and Oxford line with the South-Western Railway.

"4. That the South Wales line, and its branches to Monmouth and Hereford, should be permitted to be formed on the broad gauge, as sanctioned by their act.

"5. That the Rugby and Oxford line, and the Oxford, Worcester, and Wolverhampton line, should be permitted to be formed on the broad gauge, as sanctioned by their acts; that the Lords of the Committee of Privy Council for Trade shall exercise the powers conferred upon them by the several acts, and shall require that additional narrow gauge rails shall forthwith be laid down from Rugby to Oxford, and from Wolverhampton to the junction with the Birmingham and Gloucester line; and that if it should hereafter appear that there is a traffic requiring accommodation on the narrow gauge from the Staffordshire districts to the southern coast, any suitable measure shall be promoted by Parliament to form a narrow gauge link from Oxford to the line of the Birmingham and Gloucester Railway."

THE GAUGE COMMISSION.

Analysis of Evidence given before the Royal Commissioners appointed to investigate the subject of the diversity of Railway Gauges.

(*Continued from page 183.*)

MR. JAMES EDWARD M'CONNELL: Is, and has been for upwards of four years, superintendent of the locomotive department on the Birmingham and Gloucester Railway, now part of the Bristol and Birmingham. If as large an amount can be got of evaporating space, compared with the weight of the engine, on the narrow as on the broad, they would be equal in that respect.

Dimensions of Mr. M'Connell's Locomotive Engine at Bromsgrove.

The dimensions of the Great Britain Locomotive Engine, constructed at Bromsgrove Station, and now employed to work the heavy goods trains upon the Lickey Incline on the Bristol and Birmingham Railway, are as follow, viz.:—

	Ft.	In.		Ft.	In.
Diameter of cylinders	0	18	Diameter of pump rams	0	2½
Length of stroke	0	26	Breadth of shell of fire-box	4	4½
Diameter of each of the six wheels	0	46	Length of ditto, outside	3	11
Distance from centre to centre of front wheels	6	9½	Height from bottom to top	6	3
Distance from centre to centre of hind wheels	6	11	Height of lower edge of cylinder	2	0
Length of boiler	12	0	Length of chimney	6	9
Length of tank over boiler	11	9	Circumference of ditto	3	6
Breadth of ditto	3	7	Total weight of engine	30 tons	
Depth of ditto	2	7	Weight on front wheels	9 tons	
Distance from centre to centre of cylinders	6	2	Weight on centre wheels	12 tons	
Length of tubes, No. 134.	12	6	Weight on hind wheels	9 tons	
Diameter of ditto	0	2	Height of smoke-box	6	1½
Diameter of piston rods	0	3	Width of ditto	4	10
			Diameter of boiler cylinder vertically	3	10
			Ditto ditto horizontally	3	9

The Lickey incline is one in thirty-seven, which is a very steep gradient, and has always been worked by a locomotive engine. For the last four years, engines were of so light a construction that they had not sufficient adhesion on the driving wheels; in order to test the relative economy of a heavy and light engine in working this steep gradient, witness made an engine which has been at work now the last two months, with a cylinder 18 inches diameter, stroke 26 inches, and the driving-wheels 46 inches diameter, six wheels, all coupled. The engine carries its water in a tank on the top of a boiler, so as to give it the advantage of all the weight possible to increase the adhesion of the wheels, and it weighs in working order somewhere about 30 tons. There is a great variety in the weight of the engines on the two lines, from 10½ up to 30 tons; the average weight of the 30-inch cylinder passenger-engines is about 12½ tons, with 5 feet driving wheels. Four have 5ft. 6in. wheels, for mail and express trains, and weigh about 13 tons. The average speed of express trains about 30 miles an hour, with 15 tons load. The luggage van is about half a ton lighter than the passenger carriages, and is placed next the engine. For the last three years, the van has been placed there, on the recommendation of the Board of Trade, for public safety, and if they had two, or any empty carriages, they would be placed there to prevent risk to passengers. Is aware that the lighter the carriage with high velocity, the greater is the tendency to run off the rails, but thinks when the luggage-van is loaded, the weight is sufficient; and the empty carriage is about as heavy as the loaded van; should not place an empty van there; would place two loaded vans if he had them. The relative speed of heavy goods trains on the two lines averages on the broad 8¾ miles and 13 on the narrow. The broad gauge wagons do not load more heavily than the narrow; that is the result of the regular working of the traffic. 135 wagons upon the narrow gauge carried 138 tons net; and that on the broad gauge, 135 wagons carried 134 tons net. On one occasion, the gross load upon the broad gauge conveyed by Mr. Slaughter's engine was 235 tons 2 cwt.; the tare was 137 tons 12 cwt.; the net was 97 tons 10 cwt. On the narrow gauge the gross load was 254 tons 9 cwt., the tare 101 tons 17 cwt., and the net 152 tons 12 cwt. The wagons were taken and loaded expressly, that there should be as little dead weight as there possibly could; and this is a further proof of the comparative net and tare upon the two gauges. There were 36 wagons upon the narrow gauge, and 25 wagons upon the broad gauge. On the latter the gross load was 235; on the former 254. With 35 tons 15 cwt. less tare, there was on the narrow gauge 55 tons 2 cwt. more net. Went up two inclines of 1 in 100 at a speed of 8 miles an hour. On other portions of the line, that is, on level portions of the line, and slight inclinations, our maximum speed was 25 miles an hour. Size of the engine on the broad gauge: cylinder 16 inches diameter, stroke 24 inches, wheel 54 inches, gross weight of engine and tender 23 tons. Size of engine on the narrow gauge: cylinder 15 inches diameter, stroke 24 inches, wheel 54 inches, weight of engine and tender 27 tons. All six wheels were coupled in both cases, so as to get the utmost adhesion to the engine. The Birmingham and Gloucester is laid with longitudinal bearings, thinks the Bristol and Gloucester is also laid with them. An increase of the boilers would increase the weight of the machine, and thinks that, at a high velocity, a very heavy engine would act very injuriously on the rails; so far as it is safe for the rails, the increase of the weight and power of the engines to produce speed, can be got on the narrow as well as on the broad gauge. The consumption of coke, consequent upon the generation of more steam, would be greater, but thinks it is cheaper to work with one large powerful engine, than with two small: has an engine on the narrow gauge capable of taking 600 to 700 tons, and his engine will take 1000 tons on lines of easy gradients, at 10 or 12 miles an hour. Thinks the injury to the rails and permanent way would be very much increased by increased weight and speed. Believes the injury to the permanent way on both gauges is more caused by high velocity than increase of weight. Has observed that the shocks received from the fast trains appear to affect the rails more than the slow, and the contractors for the repairs do not like fast trains so well as heavy ones at slow speed.

Has not seen the fractures of axles on the broad gauge; has seen them on the narrow. A very extraordinary change takes place in axles from the constant blows the wheels receive; it amounts to what is called cold swedging on the anvil, and renders them more brittle, which must exist to the same extent on the broad gauge; on the narrow, axles have broken that had worked three or four years, and though at first they might be fibrous in their texture, yet on fracture they appeared as if broken up into small crystals; considers the breakage of axles must arise generally from this, and the greatest care is required to get them of the best manufacture, and of the toughest and strongest iron. Prefers those of the patent axle company, near Wednesbury, with radial bars all welded together, and finds them, from experience, superior to the Low Moor. The elasticity of the long bearing of the axle would affect the wheel, throw it out of the perpendicular, tend to injure the railway, and force it out of gauge; on curves, an objection arises again to the broad gauge, as one wheel has to travel over greater surface than the other, there is either a straining of the wheel, or a twisting of the axle; the axle will be strained and deteriorated in this manner more on the broad gauge than on the narrow.

100 miles is a fair day's work for an engine, but he sees no objection to doing more; thinks that by seeing that the engines are in good order, and changing them once a fortnight, there is economy in working as much as 150 miles; the steam being raised in fewer engines would save fuel. Is aware that the London and Birmingham Company change their engines at Wolverton; they make a trip each way, being 120 miles a-day, without putting out the fire. If the gauge were uniform at Gloucester, one-third of the present staff of porters could do the goods trade; at present they are kept for lifting goods from one wagon, and repacking them in another, which requires five to six hours from their arrival. The guards' returns show, during the month of August, an average detention of 16 minutes for passenger trains. The detention to goods trains by transhipment from one gauge to another cannot be estimated at less than from 4½ to 5 hours. Thinks the alteration of gauge matter of necessity, and that the cost would form a very small practical part of the ultimate profit. Supposing the cost to be £5,000 a mile, has no doubt the increased profit would more than cover the interest of the outlay, but thinks £5,000 is very much too high a sum for the alteration, for this reason—with respect to the wagon-stock, it would take for instance for 50 miles of railway a certain number of wagons, but for 100 miles of railway it does not take a double number of wagons, because if the wagons work through, a small addition, comparatively speaking, would work the 100 miles beyond what is required for the 50. And so with respect to all the carrying stock. Having the carrying stock for the Birmingham and Gloucester portion, it would require a very small addition for working the other portion of the line, comparatively speaking. To lay down the broad gauge to Birmingham would amount to a complete demolition of the present works; the bridges and tunnels are too narrow, and the stations must be removed. Imagines the expense would be very great, almost a re-making of the line. The largest goods train he ever knew to arrive from the north at Gloucester was 320 or 330 tons gross weight, but thinks only a small quantity was transhipped to the broad gauge, as it consisted chiefly of salt shipped at Gloucester. In many cases, a day is occupied in transhipping. Recollects 40 or 50 loaded goods wagons waiting at Gloucester a fortnight for broad gauge wagons to come up, and that may occur either way. No mechanical arrangement at Gloucester for transferring goods, but manual labour and cranes. At first, shifting on low trucks was proposed, but on inquiry, they did not go to this expense. Goods wagons placed on additional trucks would not pass under the narrow gauge bridges, but they could on the broad. The weight of the additional trucks on the broad gauge would be about 3 tons 5 cwt. Although mechanical arrangements may work well experimentally, believes they will be found in practise totally unfit for every day traffic. The strength of the railway carriage and body is increased by their being united, and being exposed to rough usage, a separation would be a constant cause of damage to the carriage and the goods in it. Thinks that detaching the bodies of passenger carriages from the wheels and frames would be highly objectionable. High velocities would not increase the expense on the narrow as much as on the broad, the lighter machine on the narrow having less tendency to damage the rails. The permanent way on both lines is kept up by contract, and the expense on the Birmingham and Gloucester is about £100 per mile. The rails on the latter were originally too light, and the timbers and cross sleepers of the embankments not sufficiently seasoned, nor put into the Kyanizing process, so that the expense of repair has thus been increased. A line well made would be kept up at a very low expense. Believes that 75 lb. rails are now adopted on all lines, and they are to be substituted for those on the Birmingham and Gloucester.

Description of the improvements on the narrow gauge engines with six wheels.—The general features of both are as follows: Mr. Robert Stephenson has always advocated the six-wheel engine, and has made it; he has improved it very much; he has simplified the arrangement and construction of the engine; he has adopted the outside cylinder to his passenger engines, with a framing rivetted to the boiler plates; and he works his slide valves in a vertical direction. He has very much increased the length of the boiler. The average length, before it was varied by Mr. Stephenson, was from 8 to 10 feet, and now Mr. Stephenson has adopted the 12 feet tube and upwards, thereby safely calculating that a very great economy is effected in the consumption of fuel, that is, that a less proportion of heat is allowed to escape unprofitably up the chimney. This engine is found to answer in practice exceedingly well, inasmuch as it gives a greater length of engine on the rails, and increases very much its steadiness at a high speed. He has also a patent for placing the whole six wheels between the fire-box and the smoke-box, whereby he is enabled to distribute the weight more equally on the wheels. In working the engine he also uses what is termed the expansive motion, the link motion. It enables the driver of the engine to regulate the supply of steam to the cylinder in proportion to the load. There are various plans of doing so. There is a plan proposed and patented by a Mr. Bodmer of Manchester and Mr. Myers of Mulhausen on the Continent for doing the same thing, all tending to the saving of steam, and providing the quantity of steam requisite to overcome the load. The size of the engine is increased. At one time it was considered that from 12 to 13 inch cylinders was a good average size for working railways. Now we find from experience that economy of working is very much assisted by taking the train by one heavy engine instead of two light ones: that is to say, you save the wages of two men; and the expense of repairs is very much reduced, and materials, for instance, oil and tallow, &c., and the consumption of coke in the one engine is not at all equal to the consumption of the two, which would only do the same amount of work. The practice has become general on narrow gauge railways to adopt 15 inch cylinders instead of 12 inch, and even higher than that. There are at present engines being made at Messrs. Sharp's manufactory at Manchester with 18 inch cylinders of nearly the same size as the one at work at Bromsgrove, but with 24 inch stroke, 4 feet 6 inches driving wheels. They are intended for the Sheffield and Manchester Railway and the Manchester and Birmingham, and it is calculated they will be of very great service with heavy goods trains, and enable them to carry at a very low cost indeed. Those engines will be equal to take 800 tons, and travel with ease when they are at work; proving that, so far as the power of an engine is concerned, the power of getting machinery on the narrow gauge is sufficient to take any load; it will be quite equal to produce it, at least as far as it can be properly adopted without increasing the weight of the machine to the injury of the permanent way. Our power is increased more than it would be warrantable to increase the weight of the machine, of which the engine at work at Bromsgrove is an instance; for although it is 30 tons in weight, the whole six wheels can be made to spin round and slip with the six wheels coupled. That settles the point completely that we can get sufficient power on the narrow gauge, without at all injuring the construction of the engine, or rendering it objectionable. With respect to those engines that are in construction by Messrs. Sharp at present with the 18 inch cylinder, it is a most remarkable thing that the cylinders are not placed outside the wheels, but inside, so that there is room for two 18 inch cylinders in the narrow gauge to be constructed inside the wheels, working with the crank shaft. That does not much affect the centre of gravity; the cylinder is kept low; the valves are underneath in this case. The principal objection is the crank shaft, to get room for the boiler; but on the drawing and on the elevation of the engine, the centre of gravity does not seem to be at all too high. Those engines have four eccentrics, and are to be worked with the link motion. Thinks a speed of from 12 to 20 miles an hour with a goods train, as great as would be safe with this weight of engine on either gauge. These engines not used for passenger trains, the wheels being only 4 feet 6 inches in diameter, and wanting adhesion as well as power.

Description of the improvements on narrow gauge engines of the second kind, namely, those with four wheels.—Mr. Bury has always been a maker and supporter of the four-wheel locomotive engine. They are in use on the London and Birmingham Railway and several other railways. They also have been much improved; the boilers have been lengthened to about 11 feet; they have been increased in size with 15 inch cylinders and 2 feet stroke. The interval between the fore and hind axle is somewhere about 6 to 7 feet; in those of Mr. Stephenson's the distance is rather less than 12 feet; they are all in the space between the fire-box and the smoke-box. A plan is adopted on the London and Birmingham, of attaching the engine to the tender by a draw spring, rendering it an 8-wheeled machine. Believes, with the inside bearings adopted by Mr. Bury, that the engine would go on with the axle broken. Has seen them going 12 or 14 miles an hour with the axle cut through. Has known the axle broken, and not discovered till the train was at the station. The breaking of the axle takes place close to the journal, and sometimes at the corner of the crank, the iron being cross there, and not so strong. Prefers the straight axle with outside cylinders for safety. The chief objection to the crank axle is liability to give way.

John Urpeth Rastrick, Esq.: The largest engine on the London and Brighton Railway is one of 15-inch cylinder. Gives a preference to the cross over the longitudinal sleeper, as it is much more easily rectified and kept in order. At the time the extension of the Greenwich Railway (that is, the widening out of it where the Croydon, Dover, and Brighton Railways run over it,) was proposed to be done, the Directors of the Greenwich Railway Company desired their engineers (Colonel Landmann and Mr. Miller) to make a report upon the sort of rails they ought to use in the laying down of those two lines. Each of those gentlemen made out a report; one recommended rails to be laid of the same size as those that are laid on the Croydon Railway, which is a rail that has got a flat top to it; it is rather a low rail, with a wide flange at the bottom, and a narrow rib between the top and the flanch, and that was to be laid on longitudinal bearers. The other gentleman recommended that the rails should be made about 75 lb. per yard (these are called the H rails), and fixed in cast-iron chairs with wooden keys. The Directors of the Greenwich Railway Company did not think proper to take upon themselves to decide which of those rails should be laid down, and they sent the reports that had been made to them, to witness (of course not putting the names of the engineers to the reports, but merely stating that they were the reports of their engineers), and requested an opinion as to which of these methods they ought to adopt. Advised them to adopt neither of the rails, as the Croydon rail seemed (that is the light rail, and the light longitudinal bearer,) altogether too weak, and the other was not so well adapted for a viaduct as it would be if laid on longitudinal bearers, but a stronger rail; therefore recommended them, instead of making use of a cross sleeper, with a 75 lb. rail, to make use of a bridge rail of 80 lb. per yard, which had got a wide flange at the bottom. The rail was about 2¼ inches wide at the top. The flange was half-an-inch thick, and the outside width of the flange was six inches, and each of those sides was three-quarters thick; these rails were screwed to the timber; screw pins went through the longitudinal timbers, and underneath there were bars into which the screw-pins were screwed. By placing an auger-spanner on the top of the pins, the rails can be screwed down most securely. The rail laid down on the viaduct of the Brighton Railway was found to answer so well that witness recommended its adoption to the Greenwich Railway, and those rails are now laid down there. The nut keeps its hold and will run back, because it can at any time be screwed up; they have nothing to do but to apply an auger-spanner on it. Is laying down a railway from Hastings to Lewes, and likewise from the Chichester line, from Shoreham to Chichester, with rails of that description, but on cross bearers with this addition, that to each of them, at the joints, there is a wrought-iron plate into which the two rails slip. There is a wrought-iron plate about 10 inches long, turned up on the edges, so as to form grooves; the two rails come together into this wrought-iron plate; the rails cannot separate, and of course that part which turns down on the upper flange of the rail keeps the one rail from rising above the other. In laying down these rails on the Greenwich Railway, we had no provision of that sort, and consequently they are liable in some degree to rise one above the other, unless the screws are kept tight; but even if the screws are all slack where these wrought-iron joint plates are used, they cannot rise one above the other. The rails were laid on cross sleepers; did not use the screw-pins at all, but merely a parallel bolt five-eighths of an inch in diameter, which holds better than screws or any other contrivance. We bore a hole half an inch in diameter, and then drive in the bolt; in fact, they hold so very fast, that in endeavouring to get them out sometimes on the Brighton Railway when a chair has broken, we have had to bend the pin backwards and forwards considerably before we could pull it out.

The velocity of the express trains on the Brighton is about 34 miles an hour, with one stoppage at Red Hill. There is very little oscillation if the road is in good order. Outside cylinders do not produce any yawing motion; it is impossible any such motion can be produced, unless there is a play in the framing itself. Considers the outside cylinders to be very much preferable to the inside, and they run a great deal steadier.

Mr. Henry Pringle Bruyeres: Is superintendent of the London and Birmingham Railway, and controls the general arrangements both of passengers and goods. Average speed of express trains on London and Birmingham line between station and station, exclusive of stoppages, rather more than 40 miles an hour, making no allowance for slacking and regaining speed. Including the stoppages at stations, the speed is 37 miles an hour. Does not think the greatest speed at any time exceeds 45 miles an hour for any distance. Passenger carriages on London and Birmingham line greatly improved. The improvement in the first class carriages is, as respects the construction, making the under framework stronger, and making it solid instead of open, as it was originally; in point of comfort to the passengers, in making the carriages larger altogether; each compartment being longer, to give more room for the legs, and higher. The carriages the company now build are in size proportionate to those on the Great Western Railway, with the exception that they may be three or four inches less in height. The reason of having them less in height is to allow of the luggage being conveyed on the roof; however, ample room is given, even for a tall person with his hat on inside. The luggage placed upon the tops of the carriages is principally "through" luggage, belonging to passengers that are going a long distance, so that when they arrive at the end of their journey, instead of having to seek their luggage at the forward part of the train, it is over their heads, and if they can only divest themselves of the idea that they are in a crowd upon their arrival, and remain stationary on getting out of the carriage, they will find their luggage immediately before them. All inside cylinders, and only one six-wheeled engine. The Company are now building six-wheeled engines. The engine and tender are tightly screwed together. Probable expense of London and Birmingham goods wagons into loose boxes for transfer on to broad gauge, about £50 per wagon. The London and Birmingham line now so consolidated, that the rains have little effect upon it; subsidence of the ballast does not take place upon the embankments.

The area of the Rugby Station is about 12 acres, including the portion used by the Midland Railway, as well as the London and Birmingham.

Dimensions of old and of new carriages.—They consist of three compartments, holding six persons each; the old carriage was in length, that is between the persons, face to face, 4 feet 11; the new are 5 feet 9, being an increase of 10 inches; the width of the old carriage was 6 feet, and the new is 6 feet 6, giving 2 inches more in width to each seat. The height of the old carriage was 5 feet, and the new ones are 5 feet 7, giving an extra height of 7 inches, that is between the floor and the ceiling, and taking it at the centre of the ceiling; the roof is curved about 2 inches, and is 5 feet 5 at the two sides. The outside length of the old carriages was 15 feet 6, and of the new, are 17 feet 6. That is the entire body. The width was 6 feet 6 in the old, and is 7 feet in the new. The height, allowing for the curve mentioned before, would be 5 feet 2 the old, and 5 feet 8 the new. The total height above the rail of the top of the carriage is 8 feet 9 the old, and 8 feet 10 the new. The additional height inside has been obtained by lowering the floor.

At present, if the Great Western Company require engines from the North of England, when not carried by water, they come up upon the London and Birmingham, and are transferred from Euston-square to Paddington, and run down the Great Western line. This has frequently been the case; they are brought up on trucks. The comparative dead and net weight carried by the down express train for the month of August, 1845, is as follows: number of passengers, 1,613; carriages, including luggage van, 132; weight of passengers, at ten to a ton, 161 tons; weight of carriages, 556 tons.

Cononel George Landmann: Was engineer of the London and Greenwich Railway and the projector of that scheme. When the line was constructed, used a very light rail, of 50 pounds to the yard. Subsequently changed those rails for others of a heavier description, weighing 65 pounds; the first rails did not reverse; the present rails do reverse; the new part is upon the Great Western principle, upon longitudinal sleepers; in the first instance, used stone blocks, which were afterwards changed to transverse sleepers. The widened portion of the line, from London to the separation of the Croydon, and the portion from Deptford to Greenwich, originally laid upon longitudinal sleepers, with the same form of rail as the Great Western; that rail was 60 pounds to the yard, whilst the Great Western was 43 pounds. The longitudinal sleepers between Deptford and Greenwich are 12 inches wide by 6½ deep; those upon the widened part are the whole size of the baulk; 12 and 13 inches, with ties across the same depth, to preserve the gauge. The longitudinal sleepers of the Greenwich line, extending from Deptford to Greenwich, rest upon transverse sleepers, 10 inches by 6, by 6 to 7 feet long, and placed at distances of about 4 feet apart, and to which the longitudinal sleepers are spiked; these sleepers were all Kyanized, and, as far as witness has been able to discover, are still quite sound. With longitudinal sleepers a lighter rail might be used than would be required where there is a space between the supports; and if the ground be properly made at first under longitudinal sleepers, is of opinion that that would be the best mode of constructing a line; objects to the mode adopted under Mr. Rastrick's direction of laying the rails upon the widened portion of the Greenwich Railway. Witness's design was to have transverse sleepers, with the longitudinal sleepers upon them; it now entirely rests bedded upon earth; if it had had fixed points to rest upon, it would have been much more secure. Should rely entirely upon the bearing upon the transverse sleepers. It is not found too elastic upon the Great Western; the longitudinal sleeper is only 7 inches thick; they have no transverse sleepers. The engines on the Greenwich line weigh about 14 tons with the water. Some are six and some are four-wheeled engines; four-wheel engines are going out of use as fast as they become destroyed; upon a portion of the line (the Brighton and South Eastern line) they run with much heavier engines, weighing 16 or 17 tons.

CHARLES VIGNOLES, Esq.: Laid out the Eastern Counties with Mr. Braithwaite, but that gentleman executed it; a question as to the gauge arose; was then very desirous of making the gauge wide; Mr. Braithwaite's view of having a 5-feet gauge was adopted; should have preferred a 6-feet gauge. Intended the Dublin and Kingstown Railway to have been a 6-feet gauge; but the Directors overruled his opinion, on the plea that so short a line might, if necessary, have its gauge altered without inconvenience; they had to obtain all their first carriages and engines from England, where 4 feet 8½ was the prevailing gauge, and they were very unwilling to depart from it; he has been consulted in laying out many principal lines, and also on the gauges of many; the Edinburgh and Glasgow was laid out, though not executed by him; as it was likely to connect ultimately with lines coming from the south, on the 4 feet 8½ principle, that gauge was adopted; some Scotch lines already executed are on rather a narrow gauge; thinks one coal line, the Forfar, was 5 feet 6 inches; but the general feeling was strong that connection with south lines should be kept in view; most of the lines mentioned were previously to the introduction of the broad gauge by Mr. Brunel. On the Continent, as the engines and carriages were obtained from England, they were unwilling to deviate from the fixed rule; the first railway in Brunswick was about 30 miles to the foot of the Hartz mountains, and the English gauge was adopted; the latest large operation of his on the Continent was laying out the Würtemberg railways; there the question of gauge was greatly discussed, and is not yet settled; they are intended to unite the railways in Baden, which run parallel to the Rhine, and those in Bavaria, which run from the Danube; the gauge of the Baden railways is 5 feet, or 5 feet 6, and that of the Bavarian 4 feet 8½; under all the circumstances, he recommended that 4 feet 8½ should be adopted; as all the railways in connection with Bavaria, and all the Saxon and Austrian, are 4 feet 8½, and as a great transit trade was coming from those countries, he considered that the larger amount of traffic would be from those of 4 feet 8½, and that the length of rail on the Baden side, next the Rhine, would be short in comparison; he thought Baden would ultimately be obliged to change, and bring it to the gauge of the others on the Continent; however, Baden and Bavaria persist in not changing, and it is a question at what point the transit shall take place, whether on the eastern or western frontiers of Würtemburg; thinks the probability is, that they will ultimately adopt the 4 feet 8½ gauge throughout Würtemburg.

As to the cost of the carriage-frame, thinks it would increase as the squares of the gauges, but with a certain additional amount of accommodation; one great advantage of a large carriage is, that you get less gross weight in proportion to the net; does not know whether that has been realized in practice, but thinks it ought to be so. As regards increase of speed, does not think on that alone the Great Western have an advantage; the trains travel very fast on it, but much more is due to the gradients, which are very flat, than to the gauge; with respect to economy of working, the expense on the Great Western and the London and Birmingham is as near as possible the same. With respect to safety, as far as it is connected with steadiness, is quite satisfied that at very high velocities the trains travel more steadily on the Great Western than on the London and Birmingham, taking the gradients as they occur. In the abstract, is quite satisfied there is greater steadiness of motion on the broad gauge at high velocities. If the road happens to be out of order, or the springs of a carriage stiff, or if it is not loaded or overloaded, or a little slack in the coupling up, or too tight—all those will affect it, particularly at high velocities; has not made a series of experiments, but is quite satisfied that it is steadier with the broad than with the narrow gauge at a high velocity. It is impossible to write on the London and Birmingham at a high speed; he could read in their express trains very well where the road was in good order, but when bad could not.

Used to be, and is still, very partial to the longitudinal sleeper; but some facts have come to his knowledge to shake his views, in particular, on a foggy morning on the North Union, when an engine comes to the longitudinal sleepers she invariably slips, which does not take place on the cross-sleepers; cannot account for it. It may be owing to a dampness that remains on the longitudinal sleepers which may impart to the rail a moisture which converts dust to mud, and produces greasiness. The soil is chiefly sand, with probably a little clay in that portion of it; but still, wherever the longitudinal sleepers are, the engine has a great tendency to slip. Has often calculated the relative cost of laying rails on the longitudinal and cross-sleepers; it was very much in favour of the longitudinal in the first instance, where a slighter baulk was used; but as it is now necessary to have the whole, or at all events a three-quarter baulk, the balance is against the longitudinal as the more expensive; a very heavy rail, with a cross-sleeper without the chair, answers very well, and is the most economical mode. The first Liverpool and Manchester rails were 35 lb., and the 42 lb. rail on the Dublin and Kingtown is still in use. On the lower part of the North Union the 42 lb. rails have been taken up and replaced by 63 lb. On that line the passenger trains are light, but the merchandize and coal excessively heavy. The lengths of bearings are 3 feet 9 inches and 4 feet; four to a rail.

Should the Grand Junction Company alter to the broad gauge, it would be practicable to alter the North Union too, as the bridges and tunnels are sufficient for the purpose; none of the bridges are less than 30 feet span, and those of the Great Western are not more. His practice is to make bridges about 30 feet. The tunnels are about 27 feet. On the Midland Counties the bridges are all 30 feet; the viaduct at Rugby is 27, which would admit of the broad gauge by corbelling out the parapet; the Great Ribble Bridge on the North Union is 27 or 28 feet wide, and the tunnel into Preston, the only one, is nearly 30 feet. With less than 30 feet there would not be room for a man with safety; it would be better to have recesses built in the tunnels. Thinks, by a judicious system of transfer of bodies, the packing and unpacking at Gloucester might be avoided. The passenger carriage-bodies may be transferred, as at Rouen, to the frame of the railway carriage, without any risk or difficulty. Has ridden in one of those carriages, and been lifted up with it, without any practical inconvenience. It is bolted down, and is as perfect as if it were the railway carriage itself. A carriage put together in that way is as strong as a usual one, in case of collision; it is strong enough to be lifted, and, being required for the road, is stronger than the railway carriage. Considers the 7-feet gauge wider than is necessary; the wider the gauge, the more the effect of curves is felt; does not think the gradient at all enters into the question. The Great Western have large driving-wheels, not with regard to gauge, but velocity; there is no necessary connexion between the diameter of the wheel and the gauge. Would not adopt the 7-feet wheel on the narrow gauge; but that is a proof that it must be steadier on the broad. A great number of things were proposed in adopting the broad gauge, which have not yet been carried out with effect. Were he the engineer of a broad gauge line, should avail himself of the increased space to make engines more powerful. The necessity of increasing the engine is every day apparent, and to have engines so far above the work that there can be no question about their power. The driving-wheel of the engine will regulate the velocity; one of the Great Western engines, with the large driving-wheel, would give the same amount of speed, whether on the broad or the narrow gauge. The diameter of the driving-wheel is quite a different question from that of gauge, except as regards the increased steadiness arising from the wider gauge.

(To be continued.)

VENTILATION OF THE HOUSES OF PARLIAMENT.

The second Report from the Lords' Select Committee to inquire into the Progress of the Building of the Houses of Parliament.

That the Committee have again met, and having examined Mr. Goldsworthy Gurney as to the best system of ventilation for the new Houses of Parliament, are of opinion that further inquiries and experiments should be made, under the direction of her Majesty's Commissioners of Woods and Forests, before the final adoption of any plan hitherto proposed for that purpose. And the Committee have directed the evidence of the said Mr. Goldsworthy Gurney, taken before them, to be laid before your lordships.

[We select from the appendix the following extracts from the evidence of Mr. GOLDSWORTHY GURNEY.]

Are you aware of all the plans proposed by Dr. Reid, for ventilating the new Houses of Parliament?—No.

Therefore you do not know what his scheme is, and how he proposes to force a due diffusion of air over all parts of the building?—Except from hearsay. I have no accurate information.

In what manner do you understand that he intends to do it?—By a large upcast shaft, the base of which is to communicate by air passages to the various apartments in the building.

Do you suppose that that is to be assisted by any power either of furnaces or steam power?—I suppose it must be assisted by a blowing cylinder, or a centrifugal fan. Those adjuvants would be unnecessary if the upcast shaft had sufficient power. They are always objectionable, in consequence of involving machinery, and being liable to get deranged. Yet some mechanical assistance must be had; for if this extensive building is to be ventilated by the upcast shaft it must fail. The size of a shaft would be inadmissible, for it will be evident to your lordships that the whole of the air drawn from the whole extent of the building ventilated must pass through it. This is not all; the whole of the air drawn out of the different apartments, and passing through the shaft, must be raised to the temperature of 500° of Fahrenheit, otherwise it will have no power. That is a very important point; one to which I wish to fix your attention, and explain as clearly as possible. Suppose the buildings of the new houses extend over ten acres of ground; suppose five acres—one half only—occupied by rooms, the sectional area of the five acres of rooms will be, in round numbers, 200,000 feet, accurately 217,600 feet square, which is about the square surface of five acres of ground. Suppose the movement of air to be at the rate of 11 feet a minute, which it must be for good ventilation, the quantity of air discharged must be 2,393,000 cubic feet per minute. Now the whole of this 2,000,000 cubic feet of air must be heated sufficiently high to produce an available power, by the difference in the weight or balance of the internal and external columns. A temperature of 500 degrees Fah. believe, is necessary to produce any available pressure. The whole of the air must, therefore, be passed up the chimney, and then raised to a temperature of 500 degrees of heat as it passes. This appears to be impracticable. But supposing it possible, the quantity of fuel burnt could never be suffered. On referring to experiments made by myself some years since, I find a pound of charcoal will heat 1,000 cubic feet of air from 60 degrees only to a temperature of 500 degrees. Therefore, if we take this as sufficiently accurate and favourable data, we shall find that we require at least 2,000 lb. of fuel per minute. The impossibility of being able to consume this quantity of fuel is evident; it is not possible to burn this quantity of fuel. To produce practically a discharge of that quantity of hot air, or effect an available power, it must be borne in mind that air raised from 60 degrees to 500 degrees doubles its volume.

You object, also, to the system of ventilating from the floors or sides of the room instead of from the upper portion of the apartments?

Yes; there is a practical objection to this direction, which will be seen by looking at the subject carefully. These retrograde currents produced from air entering at a low level into a room are practically very objectionable; they produce an increased rate of evaporation upon the skin, which produces a sensation of cold. Although the temperature of the air in motion itself may be warm—say 70 or 80 degrees—it will produce a temperature very considerably lower on evaporating surfaces. The skin of the human body is essentially an evaporating surface, and suffers much from this law. The feeling of cold in the parts of a room where retrograde or direct currents act is not due to the actual temperature of the currents, but to the increased rate of evaporation produced by them. Evaporation produced by retrograde currents rapidly absorbs heat. A person cannot get out of the influence of the direct or retrograde currents if they enter near the floor or at a low level, but if the openings are made in the ceiling or at a high level, then they are mixed with the atmosphere of the room above, and cease or become destroyed before they can possibly reach any one standing on the floor.]

Although not evinced by the common thermometer?

Not by the common thermometer, but instantly by an evaporating thermometer.

It does not depend upon temperature, but evaporation?

It is entirely due to the increased rate of evaporation produced by a current of air passing over the surface. It is said, "If you cover the skin with ether, or some other rapidly evaporating substance, you may freeze a man to death in the height of summer." A current moving at the rate of three miles an hour, acting on highly alcoholic ether placed on the surface of a thermometer, will occasion the mercury soon to fall to the freezing point, notwithstanding the current of air may be at 80°. Evaporation where there are partial currents goes on unequally; there is a feeling of heat out of the currents, and a feeling of disagreeable cold when in them. You cannot get out of them if the entering current is anywhere where it impinges upon the person. There is a great objection to air for ventilation entering a room anywhere at a low level; it must necessarily impigne upon the person.

Will you state what force you propose to apply to set the atmosphere in motion?—I prefer the *vis à tergo* arising from the escapage of high-pressure steam; through proper sized air passages it furnishes a power capable of being managed so as to produce at will any rate of current down to almost an insensible breathing. I prefer it, also, in consequence of its great capability of management. When I state that in some experiments which I made ten years since, I raised a column of mercury nine inches by the force of the current of air produced by it, the Committee may see from that fact that it is capable of producing a force which never can be required for ventilation. M. Arago, in some experiments within the last few months, has raised by a current of air thus produced a column of mercury 15 inches. Therefore these facts prove that we have abundant power so as to overcome every opposition arising from wire-drawing or other resistance, and to compel air to pass with uniformity wherever it may be necessary. It is simple in application, and its economy great, though that is not of so much consequence as the former; it is capable of being passed easily and independently to any part of the building separately. You may act by this principle upon groups of rooms, or upon single rooms, or anywhere where it may be convenient; by that means, you prevent the necessity of cutting up the building, or the making of large communications. Another advantage which it will produce, and which though last may not be the least, is, that it is capable of passing a sufficient quantity of air, as much as can be required to produce ventilation, through small passages, which passages may be secured against the communication of flame, in case of fire, on the principle of the safety lamp. This is a circumstance of great importance where a building is to be made fire-proof. Supposing there are several rooms connected together by ventilating flues, all would be rendered safe and perfectly independent of each other as to fire by the intervention of diaphrims of wire gauze, upon the principle of Sir Humphrey Davy's safety lamp. Wire gauze cannot be introduced unless you have great command of power, because you offer by it a strangulation difficulty in the passage of air, which cannot be overcome by the ordinary means of ventilation.

You consider this principle perfectly applicable to fire-proof buildings—that it does not affect the fire-proof quality of the buildings in any way?—Not at all; but if there should be any doubt as to the safety of a wire gauze disc, or layers in succession, each room may be ventilated independently of any communication made between them; in that case it must be self-evident that there can be no danger from fire.

So that the system may be applicable either to single rooms or to an entire building?—Yes; the power is sufficient to produce ventilation for the entire building.

You are aware that Dr. Reid's view of taking the air, by which the houses are to be supplied, f om the top of this great tower, when completed, is for the purpose of getting a purer atmosphere than he thinks he can get down near the river, where it is, in a degree, vitiated by sewers and smoke; do you think that it would be advantageous to get your air from such a source for the general ventilation of the buildings?—The sewers I know little about; but in regard to smoke, the most deleterious and injurious products of combustion in London from the chimneys I believe are those which are invisible. The visible smoke—the unburnt carbon—we need not be much afraid of; it blackens our faces, but I believe does no harm to our lungs. The most serious injury is from the sulphurous acid formations, and from some of the volatilized metallic oxides: but this is a question of great difficulty, a question that much better chymists than I am must answer.

Do you mean to imply that you doubt whether air two or three hundred feet high is not likely to be loaded with much greater impurities than the lower atmosphere, which appears to be coarser?—Yes; I should have some doubt about it.

You are aware that Dr. Reid has a plan for collecting the smoke of every fire in the building, and conveying it all through one shaft?—I have heard so.

Do you believe that can be done?—I think it is very difficult.

SUBSTITUTE FOR RAILWAY SLEEPERS.

The following suggestion occurs in the Engineer's eleventh report to the Georgia Central Railroad Company, (America):—

During the past year, I have made an experiment of substituting iron cross ties for our present wooden sleepers. In renewing the sleepers as they decay we use no other timber than cypress—this is not to be obtained near the road above the Ogechee river, and we are obliged to transport the sleepers from the lower portions of the road, which increases the labour and expense.

I have long entertained the opinion that a much smoother track could be attained by removing entirely the sleepers, which support the string pieces at intervals, so as to give the string piece a continuous and uninterrupted bed of earth. I am now convinced of the correctness of this opinion. The plan is as follows:—

The string pieces (6 by 12 inches) are laid on an even, well rammed surface, and in length of from 30 to 60 feet—at the joinings, a bolster piece of the same scantling as the string piece and three feet long, is placed lengthwise immediately under the joint, and the string piece pinned to it. The iron rails, of the ordinary ⊥ pattern, are laid along the centre of the string piece, and the track is kept in gauge by the iron tie, a piece of flat bar iron, half an inch thick by two inches wide; this tie is let flatwise into the string piece, flush with its upper surface under the rail, and the ends, bent into the form of a hook, grasp the outside of the bottom web of the rail at the joint. The rail is confined in other respects as usual with the ordinary hook spikes. The track is filled even with the top surface of the string pieces. We have laid about seven hundred feet in the manner above described, on a portion of the road where the earth was springy and it was difficult to keep the track in adjustment. It has borne the transit of the trains for several months past, and keeps in much better order than with the wooden sleepers. The following statement shows the comparative expense of a mile of road with iron cross ties, as above described, and with wooden sleepers, for twenty years:—

With Iron Cross Ties for one mile.

352 iron bars, 18 lb. each, at 4 cents per lb.,	253·44 dollars
Bending the ends and preparing them, at 4 cents each	14·08 „
330 bolster pieces under the joinings of string pieces (6 by 12 inches, and 3 feet long), at 7 dollars per thousand feet, B.M., to be renewed three times in 20 years	166·32 „
Putting in 352 ties	57·12 „
Amount	490·26 dollars

With Wooden Sleepers for one mile.

660 cypress sleepers, allowing them to be left sound at the end of 20 years, will have to be renewed three times; then 1980 ties at 25 cents each	495·00 dollars
Putting in 1980 ties	471·24 „
Amount	966·24 dollars
Difference in favour of iron cross ties in a period of twenty years, per mile	475·98 „

The first cost for substituting the iron for the wood is, per mile	379·00 ,,
First cost of renewing the wooden sleepers	322·00 ,,
Difference. . . .	57·00 dollars

You will thus perceive that in a period of twenty years, a saving of four hundred and seventy-five dollars would be effected, while the additional first cost is only fifty-seven dollars per mile. The cost of putting in the ties, both of iron and wood, is estimated from actual experiment.

I have said nothing in the above estimate, of the saving which would be made in the labour of keeping the track in adjustment; this would not be less than 10 dollars per mile per annum, and would swell the difference in favour of the iron ties to nearly 700 dollars per mile in the period of twenty years.

SMELTING WITH ANTHRACITE COAL.

The following particulars respecting the first discovery of the applicability of anthracite coal for smelting iron are communicated to the Journal of the Franklin Institute, by Mr. S. W. Roberts. He states the original inventor of this important application of anthracite was Mr. Crane, who superintended the Yniscedwin works, in Breconshire. When Mr. Crane took charge of the works, and for a long time after, the smelting of the iron ore found in the vicinity was carried on with coke made from bituminous coal; but, as an extensive field of anthracite coal existed in the neighbourhood, which was considered useless for smelting purposes, his attention was early turned to the importance of bringing that fuel into use; and at different periods, during fourteen years, he had, at a large outlay, tried a variety of plans to effect the object.

Though repeatedly baffled he still persevered, and his efforts at length were crowned with complete success. Finding that the use of this hard and refractory fuel caused his furnace to chill, he resolved to try the effect of heating the blast to a temperature sufficient to melt lead, upon the plan so successfully introduced by Mr. Nielson, for increasing the yield of furnaces worked with bituminous coal.—Having made the necessary preparations, he began the experiment with the hot blast on the 7th of February 1837, in a furnace forty-one feet high and eleven feet in diameter at the boshes. From that date until the 12th of March the furnace was worked with roasted anthracite as the only fuel, and thenceforward exclusively with raw anthracite as it came from the mine without any preliminary preparation. In all respects Mr. Crane's success was complete; his furnace worked well, the yield was better than with coke, and the iron was of superior quality. He felt that the problem to which so many experimenters had turned their attention, both in Europe and America, and to which he had devoted so much of his time, was triumphantly solved. He had accomplished the object on an extensive working scale, with continued and increasing success; and from this period dates the establishment of a new and important manufacture, from which the iron trade, both of Great Britain and the United Sates, is now deriving great advantages. The writer of this notice, who was at that time sojourning among the iron works in Wales, visited Mr. Crane's establishment in May, 1837, for the purpose of seeing the process and of satisfying himself that the materials used were similar to those which exist so abundantly in Pennsylvania. Finding that the great object was accomplished, and that the results were highly gratifying, he communicated the fact to his friends in Philadelphia, by whom it was shortly after made public through the newspapers. At that time there was no blast furnace in Pennsylvania working with anthracite coal; their number in the State is now twenty-seven, and there are several in New Jersey.

At the meeting of the British Association for the Advancement of Science, held in Liverpool, in September, 1837, Mr. Crane attended and presented a paper descriptive of his process, which is printed in the sixth volume of the proceedings of that association. He had secured a patent in Great Britain and had applied for one in the United States, the issue of which was for some time delayed, owing to obstacles which grew out of the premature publication of his process. His patent was infringed, and he became involved in a tedious and expensive litigation which some of his friends feared might end in his ruin. At length, however, the question as to the validity of his British patent was decided in his favour, and thenceforward it became a source of much profit to him. He extended his works at Yniscedwin by the erection of several additional furnaces, and his concerns became highly prosperous.

ORNAMENTAL FLOORS.

At the *Decorative Art Society, May* 13, a paper "On Ornamental Floors," was read by Mr. Laugher. The subject was treated principally with regard to modern appliances, and more particularly to the use of parquetry (or inlaid wood), in our principal apartments. Some observations, however, were made respecting the pavements and floors of antiquity; of which several familiar imitations were referred to in the painted floor-cloths of the present day. Subsequently to the introduction of Canadian timber into this country, stone floors were said to have become nearly universal; and also that, for upper rooms, plaster was generally adopted. It was observed that boarded floors (usually of oak) were considered a very distinctive appurtenance to the English mansion in the seventeenth century; and that they received increased attention to ornamental effect in the early part of the eighteenth, at which period the parquet floor had obtained considerable favour, and was constructed at great cost. Carpets of home manufacture then began to enter into competition with them; and the use of foreign deals (which, from their shrinking, rendered carpeting more essential to comfort) tended to the disuse of this superior kind of flooring. It was remarked that at present there was a revival in the feeling towards parquetry; and explanations were given of several applications of steam and machinery (by Messrs. Steinitz and Co.) for accelerating, not only the production of the geometric forms of the component parts, but ulterior processes of framing and construction, whereby considerable economy in time, labour, and cost resulted. Several observations were made upon the relative cost of parquetry; and it was said that its price, when laid down marginally in dining-rooms, does not now exceed four times that of its imitation on painted cloths, and than for drawing-rooms it is not more expensive than the richer kinds of carpet. The superior results arising from having an inlaid margin of hard polished wood were enumerated.

DAMPNESS IN BUILDINGS.

ITS CAUSES AND CONSEQUENCES, AND THE MEANS OF PREVENTING IT.

In our last number (page 187) we gave part of a translation from the *Magazin Pittoresque*, of an abstract of a prize-essay, by M. Vandoyer, on the prevention and cure of damp. When we commenced this paper we were not aware of Professor Donaldson's intention of reading before the Royal Institute of British Architects a translation of the original essay. He has however since done this, and we gladly avail ourselves of a translation which, being prepared by one of the best French scholars in England, would in all probability be far superior to our own. In order however to avoid repetition of part already published, we have ventured to omit some portions of Mr. Donaldson's paper.

According to physical laws, the damp of the soil tends to penetrate, in one direction or another, the hygrometric bodies with which it meets. It hence results, that the walls of buildings will absorb from the soil a certain dose of humidity at all the points immediately in contact with it. That is to say, if there be an underground basement, the outside walls will absorb by their footings, and by one of their faces, and the division walls by the footings alone. If there be no underground basement, the division and outer walls will be under precisely the same conditions, with respect to those parts of them below the level of the exterior surface of the soil. But are these the only causes of humidity ordinarily regarded in lower parts of buildings? Certainly not; and it is easy to prove that, with regard to external walls, there are other causes, which, although less constant, are notwithstanding not less immediate;—we mean the rain-water, which the wind drives upon the faces of walls, by which the lower part is wetted; as well by that driven directly on the surface as by that which rebounds from the ground, or by that which falls down the face of the wall. In the case of dripping eaves, without gutters, it may be easily imagined the abundance of wet which the walls receive at the lower parts from the drips of water, and from stacks of rain-water pipes without shoes.

If the lower floor of a building be covered, whether it be by any pavement whatever, or by a planking, immediately upon the soil itself, it is certain that the ground under the floor contains, first its own humidity, as also the damp which traverses the foundations of the outer walls; so that there will exist always a constant humidity throughout the whole extent of the *lowermost* floor, susceptible of exercising its influence upon all bodies immediately in contact with the surface of the soil.

The paving the outer surface next the building, or its being unpaved, materially affects the dryness of the inside; and the construction of numerous and full-sized sewers and drains in large towns, also carries off a great portion of the surface waters; and again, an isolated building is more exposed than one contiguous to another; and also when a house is on the slope of a hill, with one part against a bank, through which the waters may flow, it is necessary to adopt precautions to prevent their penetrating the solid constructions.

No reliance can be placed on the impenetrability by humidity, of any material—wood, bricks, ordinary stones of every quality, marble, nay granite itself, are more or less hygrometric—that is to say, that plunged in water or kept in a humid atmosphere, after having been previously weighed in their dry state, there is not one which will not have acquired some addition of weight. Thus, if the base of a column be immersed in water, it will gradually rise up the shaft, and the damp never quits a body into which it has once penetrated, unless it be absorbed by the air or heat. If the upper part be dried by exposure, as soon as it ceases to be acted upon, the humidity of the lower portion will again rise to the dry part.

A wall, therefore, constructed of brick or stone of any quality whatever, will be subject to the damp which exists in the soil, and which will enter in all directions and in all parts, where the wall is in immediate contact with the ground. The extent to which this damp will penetrate, cannot be determined, and it may rise to a very great height above the level of the soil; and if it be arrested more or less, that will be caused by the influence of the neutralising power of the temperature of the atmosphere; so that a wall, which may be very damp at the beginning of summer will be much less so at the end of the dry season, and particularly so if immediately exposed to the sun, but the following winter the damp will return, unless the original causes of humidity be subdued.

It is desirable in all and every class of soil, to have a substratum of concrete under the footings. For the purposes of damp this need not be very deep, perhaps not exceeding a foot high. As soon as the footings and lower part of the wall are carried as high as the level of the ground inside, it will be well to introduce a thin sheet of lead the whole thickness of the wall, or a layer of bituminous substance as thin as possible, so as to penetrate the brick and stone and fill the pores, or a double course of thick slate set in cement.

The purpose of the sheet of lead and of the bituminous substance, and the slating, is to prevent the wet from rising up from the footings. But other precautions are necessary to prevent the access of damp from the surface of the ground next the outside face of the wall. A facing of stone is the best remedy. It need not be very thick, but it is well for it to be at least two or three feet high; and if a small interval between this facing slab and outside surface of the wall, so much the better, providing a circulation of air be kept up in the space. By this provision neither the rain beating against this part of the wall, nor the water returning from the pavement or ground, will be able to reach the main substance of the wall; for although the facing slabs may be temporarily damped, they will soon be dried without communicating the damp to the body of the wall.

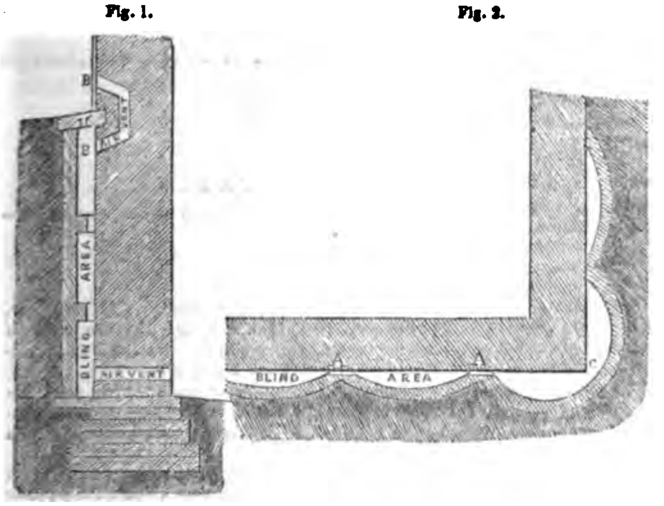
The inside of external walls should never have the plastering applied immediately on the face. They should be battened by means of long narrow slips of wood, attached by hold-fasts to the inside face of the wall. These slips or battens receive the laths upon which the plastering is applied. The space formed by the battens between the wall and the lathing effectually keeps out the humidity.

No impervious covering should be laid on wooden floors in the lowermost story, such as oil-cloth, for instance; a certain moist air always rises from the ground, and escapes through the joints of the boards, but if this be intercepted by an oil-cloth, the air will rot the boards and oil-cloth in a very few months.

But it is important to keep the damp from the floor which come upon the ground, that is, the floors of the lowermost story. It is evident that the timber of stone slabs should not be in immediate contact with the soil; for this purpose, let a stratum of concrete be laid over the whole surface of the house, six or nine inches thick at the least. Upon this form sleeper walls or piers up to the necessary height, and on them lay the plates or paving slabs; as an additional precaution, a thin sheet of lead might be laid under each pier on the bed of the sleeper walls. In palaces, as a greater precaution, and in buildings where expense is a secondary object, a thickness of asphalte might be laid on the concrete. In the dwellings of the poor it is expedient at all events, to have the sleeper walls or piers, which need be only half brick wide, and one course high, without the cement, and generally that will be a sufficient precaution; where stone paving forms the floor, bricks must be laid under all the joints. Thus will the humidity be more or less prevented from reaching the floors.

But of all precautions to prevent damp entering by the face of the wall, the best remedy is have an area, which, by keeping the soil at a distance, preclude its fatal effects on the wall. There areas may be three or more feet wide, and may serve as a passage all round the building, and afford access to cellars outside, as in the London houses; or if this, from want of space or the expense, be impracticable, it will be sufficient to have what

Fig. 1. Fig. 2.



are called blind areas, with convex walls against the earth, the points of contact with the outer wall of the house being as small as possible, to diminish the possibility of the communication of damp. Care must be taken to leave openings at A A A (fig. 2), so as to maintain a draft or circulation of air throughout the several areas; and to render this circulation perfect it will be requisite to form in the wall three or four shafts, as B B (fig. 1), to keep up a communication with the outer air. It is necessary to leave the angle C, quite free and clear, for the angle at C being a solid mass, requires the greater exposure, that it may throw off the damp, which it originally acquired by exposure to the atmosphere, as it tends to make it evaporate. The top of the areas must be covered by stone slabs, which it is desirable to keep above the surface, and the face of the wall immediately above should be rendered with cement. If it be necessary to have the covering slabs below the earth, the face of the wall must be rendered with cement, or the damp will undoubtedly penetrate through the wall from the slightest depth of ground next to it.

Another precaution must always be taken in regard to floors, and that is, to insert in the outer walls iron gratings, with channels in the wall, say 9×6, so as to let air pass into the floor from the outside; and in order to exclude the air from the floor in winter time, or the event of damp weather, it is well to prepare a sliding plate in the skirting, which may shut it off or open the holes for the re-admission of the air, as the one or the other effect may be desired.

Dripping eaves and rain-water shoots or gurgoils, without standard pipes, should always be avoided; for the water, which falls from the eaves, or gushes from the projecting spouts or shoots, is driven against the face of the wall ere it falls a few feet, and keeps the brick or stone-work saturated at times with the water. Hence eaves-gutters and standard rain-water pipes are always indispensable, and a proper shoe at the foot of the pipe should never be omitted, otherwise the force of the water causes it to undermine the wall, producing the most disastrous results, whereas a shoe keeps the water from the wall, and turns it into a drain prepared to receive it.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

June 8.—W. Tite, V.P., in the Chair.

Sir T. Deane, of Cork, made some observations on the drawings which he exhibited of the Abbey Church of the Holy Cross at Tipperary.

An address *on Ventilation* was delivered by J. Toynbee, Esq., F.R.S., Surgeon to the St. George's and St. James's General Dispensary. He introduced the subject, by stating that during the whole of his professional career he had almost constantly been attached to public medical institutions; and that he had slowly become aware of the existence of an enormous amount of disease in the human race. A large share of this disease was incurable when once produced; but he was in a position to prove that much of it could be wholly prevented. He, therefore, felt that it was the duty of medical men, while they devoted themselves to the cure and palliation of disease, also to exert themselves in behalf of preventive measures. In the performance of this duty, he had investigated the sources of disease; and he found that one of the most fertile was the want of a due supply of air in dwellings and public buildings. In speaking on the *Necessity for Ventilation*, it was shown that 10 cubic feet of air, or a volume double the size of the person, is required for the purposes of respiration and transpiration each minute. The circulation of the blood was described as the process of carbonization—respiration as the process of decarbonization, in the 170,000,000 of air cells, forming a surface 30 times as large as that of the skin. In the process of transpiration, the so-called insensible perspiration was continually given off; which, together with the vapour expelled from the lungs, amounted to two fluid ounces per hour. Thus, 500 people in a church during two hours give off fifteen gallons of water into the air; which, if not carried away, saturates everything in the building, after it has been breathed over and over again, in conjunction with the impurities it contains collected from each individual. The use of lamps, gas, and oil, was shown to deteriorate the air, and to add much moisture to it. The effects of neglect for carrying out plans for ventilation are shown in the production of three of the most formidable and frequent diseases which affect the human race,—fever, scrofula, and consumption. Numerous facts were adduced in proof of this view; and the way in which these diseases was produced was pointed out. Thus, it was shown that all those who were among the victims in the Black Hole of Calcutta, and did not perish from immediate suffocation, died, in a short time afterwards, of putrid fever. The proportion of people dying of consumption who follow in-door occupations is double that of those who work out of doors; and it increases as the space for labour is more contracted. Dr. Guy has shown that it is more common in the upper parts of large establishments, as printing-houses, &c., where the air is most vitiated. The inhabitants of towns exposed to the wind are much less liable to consumption than those which are well protected and sheltered; and the goître afflicting the inhabitants of the valleys of the Rhone is produced by a stagnation of air. Instances were cited of schools in which the mass of the children were scrofulous, and to whom an increased diet, warmer clothing, &c., was not productive of any benefit—and by the aid of proper plans of ventilation the disease disappeared entirely. The same result has taken place in the Zoological Gardens, Regent's Park, since the new dens opened to the air have been in use. It was then shown that hitherto there had been a total absence of plans for the suppy of pure air, in a sufficient quantity, to the abodes of human beings. Towns are erected in localities wholly unadapted for residences. They are constructed so as effectually to exclude the air, and often increase to so large a size as to be rendered, from that cause alone, most unhealthy.—The last portion of the address was devoted to the consideration of the means to be adopted for securing an efficient ventilation. The example set by nature ought to be followed; and the gentle changes produced by the wind should be as much as possible imitated. The great principle is to admit into rooms and houses a *large quantity of air at a moderate temperature* (60° to 65°); and that there should be an outlet for the vitiated air; the pure air to be admitted within 3 or 4 feet of the floor, and to be warmed by aid of the fire-place. The various plans for warming the fresh air were examined; and their errors were found to have been, that a small quantity was admitted through a narrow channel, and at a temperature much too high, so that its nature was deteriorated. The subject of warming abodes was also alluded to; and it was shown that, from the bad mode of construction of stoves and fire-places, and from improper materials being used, the smoke was not consumed, ventilation was rendered impossible, and the greater part of the heat dispersed up the chimney. Mr. Toynbee was happy to say that he had recently examined some plans about to be patented by a gentleman who had devoted a long life to the subject, and brought it to great chemical and practical knowledge—in which these evils would be remedied, and important advantages gained. In speaking of the means for insuring the egress of the vitiated air, it was stated that, as its temperature, on escaping from the mouth, is between 80° and 90°, it rises to the upper part of the room,—from which there should always be a means of escape. Dr. Arnott's valve had been generally used for this purpose; and thousands of people will be indebted to its use for their lives and health. If it were the custom of this country to erect statues in memory of those who, like Jenner, saved the lives of thousands of their fellow men, Dr. Arnott, in manifold ways, had earned for himself this distinction. A modification of Dr. Arnott's chimney-valve, by Daw, a working man, was alluded to and displayed,—having the advantage of always remaining open, unless voluntarily closed. Various suggestions were made, showing how plans of ventilation may be carried out; and Mr. Toynbee concluded by appealing to the architects to adopt efficient plans in the construction of buildings—by doing which, they would confer unbounded good upon the public, by the improvement of the public health.

Dr. Buckland and R. A. Slaney, Esq., a member of the Health of Towns Commission, offered some remarks on the ill effects arising from badly ventilated apartments, and from the effluvia escaping out of the gratings in the streets, which are connected with the sewers by means of a gas-light burning within lofty air shafts.

Models were exhibited by Mr. Stedall, of his patent Scolecothic Ventilator; adapted for the cure of smoky chimneys, and for the admission of fresh air into the engine-rooms and other confined parts of vessels.

SIR JOHN RENNIE'S CONVERSAZIONI.

The first of a series of four conversazioni held by Sir John Rennie, as President of the Institution of Civil Engineers, took place last month, and were very numerously attended by many noblemen, members of parliament, architects, artists, engineers and celebrated men of science. In the rooms were exhibited a large number of models and specimens of new manufactures, among the former were Mr. Maclean's proposed method for conveying Railway trains across the River Dee, by means of a platform travelling upon rails fixed on piles across the river.—A model of the President's design for the improvement of the Great Wash, in Lincolnshire, by which an area, almost equal to a new county, will be recovered from the sea; the model showed on one side the present state of the outfall, and on the other the embankments and works as they will appear when completed. —The St. Katherine's Point and Menai Lighthouses.—A model of Hallett's atmospheric railway.—Plans of Mr. G. Rennie's proposed harbour of refuge, at Dover.—Model's of Mr. R. Stephenson's long boiler engine, and the new Great Western engine.—Mr. Ricardo's instrument for showing the velocity of railway trains.

Mr. Rand's machine for making collapsible tubes excited a good deal of attention, as a skilful adaptation of a known property of tin, that when subject a high pressure it may be molded to any form without being melted. In the machine exhibited the pressure was about five tons. A flat capsule of tin being struck by a solid cylindrical punch sprung up, and embracing the punch closely, took the form of a perfect tin tube. These tubes are intended to hold some fluid substances (such as artist's colours), which it is difficult to extract from common bottles.

Specimens of wood carved by machinery, by Taylor, Williams, and Jordan, were exhibited. There was also a model of Mr. Oldham's machine for numbering and paging registers at the Bank of England.

The assembly rooms, which last year were built temporarily of wood, have this year been constructed more substantially, and were elegantly decorated in polychromic, by Sang. Suleiman Pacha was among the remarkable persons present.

FRENCH ARCHÆOLOGICAL CONGRESS.

At the annual meeting of the Congress, held at Metz, several subjects of great interest were proposed for discussion. The *Athenæum* gives the following list of questions:—Is it not possible to ascertain in churches of pointed architecture the numerical relation of the several portions, and a geometrical deduction of their architectonic forms?—Do not the ecclesiastical monuments of the Middle Ages prove the existence of an architectonic hierarchy, by which all cathedrals, and abbatial and parochial churches, and even private chapels, were severally built according to certain dispositions and dimensions?—Is not the pointed or *ogival* style better indicated by the presence of pinnacles than by pointed arches?—May we not trace the progress of the styles of Gothic architecture by the technical terms employed in architectural documents of different epochs?—What are the distinctive characters between the pointed styles of France and those of Germany? and is not the cathedral at Metz an example of transition between two varieties of that style?—Was there not in each of the dioceses of Metz, Trèves, Strasbourg, and Verdun, a special architectonic school? and if so, what were their distinctive characters?—What were the monuments which served as the prototypes of those churches with a choir at each end, so frequently met with in Germany?—If, as supposed, there was some absolute rule for building churches due east and west, how can we explain the numerous exceptions to such rule observable in Lorraine and about Metz?—What is the origin of the little gallery so commonly found on the outside of Germano-Romanesque churches?—In the architectonic decoration of Gothic churches, should not the disposition of their statuary be under the architect's control, and considered as an integral part of his original design?—What kind of pavement was employed in the civil and ecclesiastical edifices of the Middle Ages?—What were the innovations in castellated buildings brought into Western Europe after the first Crusades?—What is now the most expedient form of church-building, whether considered artistically or economically?—What is the most fitting style of decoration for churches in the pointed style of architecture?—In what cases may we venture to repair ancient monuments, and according to what general rules should such repairs be conducted?—In what proportion, and to what kind of edifices should be restricted the employment of coloured glass as church ornament?

RAILWAY GEOLOGY.

At the Geological Society, *May* 6, a communication was read: "On a disturbance in the Hastings sand and Weald clay, exhibited in a cutting on the Tunbridge Wells Railway," by Messrs. J. Prestwich, jun., and J. Morris. The principal object of the authors was to give an account of the upper beds of the Wealden series as seen on the northern side of the great Wealden elevation. It is known that sections in this part are very rare, and the sequence of the beds is somewhat obscure. In the direction along which the railway cutting is excavated the beds are repeated by a fault, and disturbed by a singular flexure, the existence of which was conjectured by Mr. Hopkins from the physical conditions of one of the lines of disturbance in the districts. The section near Tunbridge exhibits the lower part of the Wealden clay with the upper beds of Hastings sand, but does not extend to the lowest greensand. The uppermost beds seen consist of 30 feet of brownish laminated clay, to which succeed 20 feet of dark-coloured laminated clay and slate; the clay generally of dark bluish grey colour, and containing impure beds of limestone with various species of cypris, cyrena, and paludina. Other clays, and some light-coloured sandstones, which then appear, are afterwards succeeded by an important bed, in the upper part argillaceous and in the lower part sandy; and this again by a band of lignite. The fossils throughout are few, and chiefly confined to the upper beds.

REGISTER OF NEW PATENTS.

If additional information be required respecting any patent, it may be obtained at the office of this Journal.

ATMOSPHERIC PROPULSION.

John Reid Hill, of Upper Stamford-street, Lambeth, civil engineer, for "*certain Improvements in atmospheric propulsion, applicable to water as well as land carriages.* (A communication.)—Granted Oct. 2, 1845; Enrolled April 2, 1846. With an Engraving, see Plate XI.

The improvements relate—Firstly, to the mode of constructing pneumatic mains for the conveyance of goods and passengers by atmospheric propulsion, combined with the description of carriages and pistons herein described.

Secondly, to the removal of the air through the piston or piston-carriages of the mains, and also through the pistons of metallic cylinders, as now used, by means of tubes communicating with the external carriages through the openings of the longitudinal valve.

Thirdly, to giving motion to carriages, in the manner hereafter described, without the aid of a pneumatic main.

And Fourthly, to the mode of applying this power to the propulsion of passage-boats or other vessel on water, by placing the mains herein described on the banks of canals.

Fig. 1 Plate XI, is a transverse section of the main closed, with the piston-carriage, *c*, and air-tubes *f f*, for the removal of the air from the main, the apparatus for that purpose being attached to the piston-carriage. *g g*, the valves, or roof of the main, to be lined at the points where they close with soft leather, cloth, or other elastic material, attached to thin boards or other flexible materials, and covered, as indicated, with a flexible cap. *a a*, wood-paving, with iron edge-rails between the blocks, level with the surface. Fig. 2 is a transverse section, with the main open, and carriages passing through it. *h h*, steps for ascending to the roof or top of the carriage. *b*, dwarf walls. *c*, concrete foundations, or ballast. *d*, planking or sleepers. *e*, wall-plate and hinges. Fig. 3, longitudinal section. The piston carriage, in its practical application, is to be placed at a greater distance a-head of the first carriage of the train than is represented, as indicated by the break in the connecting-bar; a train of carriages for heavy goods may be continued from the piston to the passenger carriage, instead of this connecting-bar, if preferable. Fig. 4 is a ground-plan.

The engraving shows a main of sufficient width to admit of trains moving inside, each carriage is provided with rollers to throw open the upper sides; if the mains are not of sufficient size for that purpose, the carriage is to move inside, at a certain distance behind the piston, in order to throw open these valves by means of such horizontal wheels or rollers attached to the upper parts of the side of the carriage, which carriage should also serve to connect the trains to the piston when moving outside, or to connect barges on water, by such mains being laid on the bank of the canals, and this power substituted for horse-power for the purpose of towing such barges. The roof, or valves, are to be composed of a series of rafters, attached by axles or hinges to a wall plate bedded on the dwarf walls, and covered inside and outside with asphalted felt, or other flexible materials, rendered impervious to air and water, and of sufficient strength to resist the atmospheric pressure; a covering of india-rubber, or other impervious material, should likewise extend to the dwarf walls, in order to render the joints air-tight. A communication is also intended to be made between the roof of the carriages, thus represented, and the interior, by means of stairs, or a step-ladder, to enable passengers to ascend or descend as from the deck of a ship to the cabin. It is proposed, also, to convey goods and passengers by means of pistons moving on wheels, as thus described, and propelled by atmospheric pressure through close tunnels or galleries, somewhat similarly constructed, but with arched roofs, and the side-walls of greater elevation, in order to afford sufficient carriage room; and such tunnels or galleries may be illuminated by artificial lights when necessary, or by daylight through strong glass, and provided with doors in the sides for the admission of passengers, placed at any convenient distances, opening outwards, so constructed as to exclude the external air and resist the atmospheric pressure. It is likewise proposed to put carriages in motion by means of rapid currents of air thus driven through cylinders, traversing such carriages from front to rear, without the aid of a pneumatic main; the apparatus for such purpose being placed in such carriages, and the velocity with which such carriages can be moved will be in proportion to the amount of power applied to the area of the cylinders, and the rapidity with which the air is propelled through such cylinders or other channels, which should traverse these carriages from front to rear.

HILL'S PATENT PRINTING PRESS.

John Reed Hill, of Stamford-street.—Granted August 2, 1844; Enrolled September 2, 1845. (*See Engraving, Plate XI.*)

This is a very ingenious invention, by which, by means of hand labour, and without the aid of steam power, a hand printer is enabled to produce impressions with a rapidity far beyond anything that the hand-press, or any press not worked by steam, has hitherto produced. The simplicity of construction is also a great advantage, for it has neither tooth wheels, rack, or pinions for giving motion; neither has it the tapes for conveying the paper. A strong lad can work off from 1,200 to 1,500 impressions per hour with less labour and exertion than is required by the common hand-presses to work off 300 impression."

We are indebted to our contemporary the Mechanic's Magazine, for the following description.

A A are the side-standards of the machine; B B horizontal frame for support of type-table; C C type-table running on wheels or rollers; D, printing cylinder, revolving on horizontal axis; E E, inking rollers; F, distributing rollers; G ink trough and supplying roller; H treadle for foot motion; I fly-wheel for rendering the motion uniform; J grooved wheel for driving the machine; K K lever for throwing off the printed sheets; L receiver for sheets when printed; M register plate for receiving or "laying on" the sheets to be printed; N part of top of machine, forming a table when in use, but which is turned up to afford access to the type-table.

Motion is given to the machine by means of a treadle, which the pressman works with his foot, whilst his hands are employed in laying on the sheets; but this is an arrangement intended to be confined to presses for small work: in presses of larger dimensions it is proposed to use hand-wheels.

Originality cannot of course be claimed, either for producing the impressions by cylindrical pressure, or for the mode of working the cylinders, in both of which respects Mr. Hill's press differs in little, if anything, from the (now) common steam-press. The chief novelties in this press we conceive to be these; *first*, the peculiar arrangement for moving the type-table; and *second*, the apparatus for taking off the sheets when printed. In both of these respects the simplicity of construction and working efficiency of the machine are such as apparently leave nothing more in the shape of improvement to be desired.

The manner in which impressions are taken is as follows:—The form of types being fixed and made ready for printing, and motion being given to the wheel, the pressman connects the motion of the wheel to the axis of the printing cylinder by a sliding clutch; he then lays a sheet on the register-plate, with its front-edge and one of its ends in contact with a guide, and on the printing cylinder arriving at a certain position of its revolution the front edge of the sheet is secured to the cylinder by claws, which carry it round to meet the types and receive the impression. By the time the impression is completed, the cylinder has brought the front edge of the sheet within the claws of the removing arm, which claws then close, and secure the sheet; and simultaneously, beneath, the cylinder claws open and allows the sheet to pass from the cylinder by the removing claws, and to be deposited on a shelf ready for being removed by hand.

On the end of the cylinder spindle outside the frame, there is a crank-arm which pushes back the type-table after an impression has been taken, and on its arriving at its most backward position, the crank-arm quits its connection with the table, and a connection takes place between the end of the printing cylinder and the edge of the type-table, by which means a firm contact takes place between the two surfaces, which produces the forward motion of the tables and types to produce the impression.

The supply and distribution of ink are effected by the table and types running under the inking rollers in the ordinary manner of steam printing machines.

EXCAVATING MACHINE.

Moses Poole, of the Patent Bill Office, London, for "*Improvements in raising and transporting earth and other heavy bodies.*" A communication. Granted Nov. 18, 1845; Enrolled May 18, 1846. (*With an Engraving, see Plate XI.*)

This invention, for improvements in raising and transporting earth and other heavy bodies, consists in the application of certain mechanical arrangements or combination of parts for facilitating the removal of earth, stone, and other matters, when constructing or forming cuttings for railways, canals, and other similar works, which will be understood by the following description, reference being had to the drawing, which shows a section of the earthwork and side elevation of the apparatus forming the subject of this patent, and consists in the application of endless pitch-chains in the following manner:—*a a* is a framework of wood or other suitable material, forming an inclined rail or tram road, and supported by props or standards *b b b*, capable of being lengthened or shortened at pleasure. At the top and bottom of the incline there is a wheel *c c'*, round which is made to pass an endless chain *d d*. *e e* is also an endless chain passing round a wheel fixed on the axis of the wheel *c'*, and also round a wheel keyed upon an horizontal shaft *f*. *g* is a vertical shaft, which may be driven by a horse or other suitable power, and gives motion to the shaft *f* and pitch chains by means of a pair of bevil wheels. *h h* are the carts which are drawn up by means of the chain *d d*, which is provided with a number of hooks that take into an eye or link attached to the tail part of the cart. When the carts arrive at the top of the incline, they are allowed a little fall on to the horizontal rail, which, together with the velocity they have acquired in coming up, has the effect of liberating them from the hook. Fig. 2 is a back end view of one of the carts, showing the arrangement of levers for disconnecting the hind part of the cart, which is effected by pulling a string which passes over a small pulley and along the side to the front part of the cart.

SLUICE COCKS.

William Henry Waller, of Vauxhall Water Works, Upper Kennington-lane, Lambeth, in the county of Surrey, engineer, for "*improvements in sluice-cocks.*"—Granted October 31, 1845; Enrolled April 31, 1846.

The improvement consists in applying moveable bushes or facings to sluice-cocks, and in constructing them in such a manner that they shall be harder, fit more truly, and be more readily applied, and replaced when worn. Fig. 1, is a vertical section of the improved sluice cock; fig. 2, a vertical section, taken transversely to the last figure. A is the case of the cock, bored out at the points, and recesses, and the backs of the bushes *b b*, are turned in a lathe, so as to fit the recesses thus formed. The inventor prefers making the bushes of cast-iron, the working surfaces are chilled in the act of casting, and are ground with emery in a lathe. The bushes are coated on their backs with marine glue, or similar material, previously to introducing them into the cock; and after the bushes have been introduced into the cock, they are moved back in the recesses before mentioned, into a proper working position, by forcing down the valve *c*, into its place. The patentee does not confine himself to the particular shape here described, as that may be varied. *d* is a screw for raising and lowering the valve *e*; a screw-nut, *f*, formed on the interior of the upper part of the cock; and *g* corresponding ribs on the outer surface of the upper part of the valve; the ribs are to guide the valve in its movement up and down. The surfaces of the valve are chilled in the act of casting, and ground with

Fig. 1.

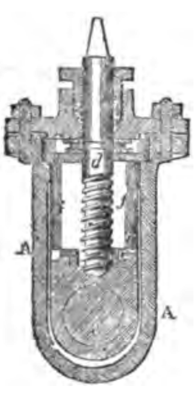
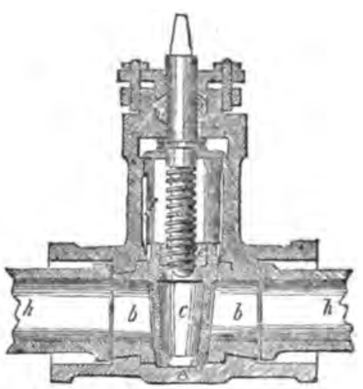


Fig. 2.



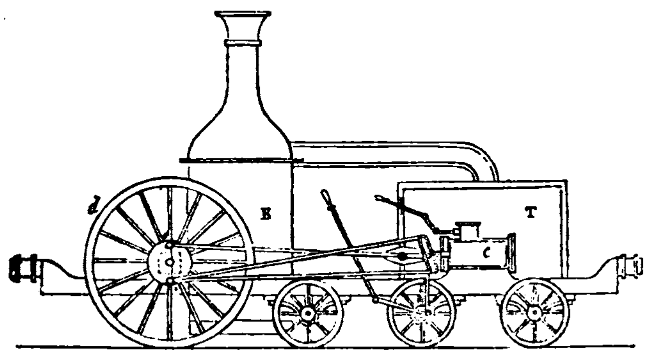
emery. *h h*, are portions of two pipes let into the sockets of the cock. For sluice-cocks without moveable bushes, the surface against which the valve works is to be chilled in the act of casting the body of the cock, so as to make it more durable; and afterwards ground true by a revolving tool and emery.

LOCOMOTIVE ENGINES.

Thomas Russell Crampton, of Southwark-square, London, engineer, for "*Improvements in locomotive engines and railways.*"—Granted Oct. 6, 1845; Enrolled April 6, 1846.

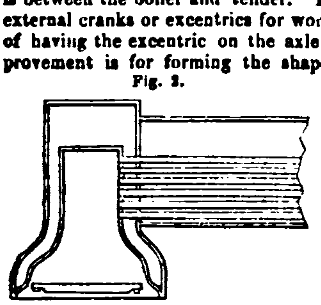
The first claim is for arranging a locomotive engine so as to include the tender on the same carriage or frame; this is effected as shown in fig. 1,

Fig. 1.



where B is an upright tubular boiler, supported on the same framing that carries the tender T with the coke and water; *c* the cylinder fixed on the side of the tender, and *d* the driving wheels; the stage for the engine driver is between the boiler and tender. The second improvement relates to using external cranks or excentrics for working the slides, as shown at *e e*, instead of having the excentric on the axle between the wheels. The third improvement is for forming the shape of the fire box, so as to increase the length of the tubes and the area of the fire grate, as shown in fig. 2. The fourth improvement or claim is for the combination of wooden rails with iron rails; the wooden rail is fixed on the outside of the ordinary iron rail, and the top is about one-fourth of an inch above the top of the iron by this arrangement the wheels of the locomotive engine may travel upon the wooden rail, and obtain greater adhesiveness, and the wheels of the carriages run upon the rails as at present.

Fig. 2.



ELECTRIC LIGHT.

Edward Augustin King, of Warwick-street, in the county of Middlesex, gentleman, for "*improvements in obtaining light by electricity.*" Being a communication. Granted November 4, 1845; Enrolled May 4, 1846.

This invention consists in the application of continuous metallic and carbon conductors (intensely heated by the passage of a current of electricity, to the purposes of illumination.

The metal to be used is that which, while it requires a very high temperature for its fusion, has only a slight affinity for oxygen, and offers a great resistance to the passage of an electric current. Platinum, though not so infusible as iridium, has but little affinity for oxygen, and offers a great resistance to the passage of the current, and as it is abundant and easily worked, appears to be preferable to any other metal. It should be reduced to very thin sheets known as leaf platinum, so thin that, on holding it before a printed page, the letters can be distinguished through it. A strip is to be cut from the platinum leaf of a width proportionate to the quantity of the current (which, with Grove's cells, having platinum plates three inches long and two inches wide, is about one-fourth of an inch), and of a length proportionate to the intensity (which, of course, varies with the number of cells); care being taken to cut the strip of an equal width throughout, and with a clean edge, as otherwise it will be unequally heated, and will be fused in one part before the other parts have attained a sufficiently high temperature to produce a brilliant light.

Fig. 1

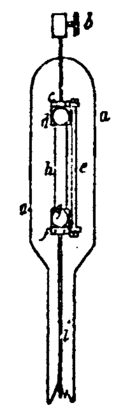
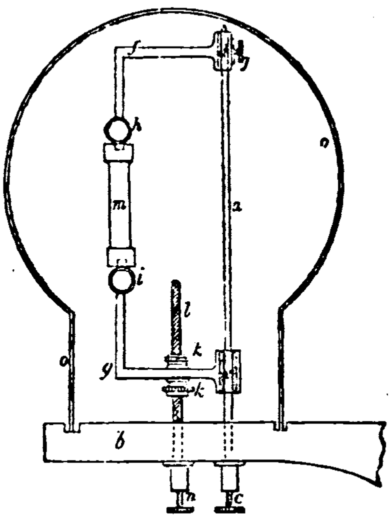


Fig. 2.



The strip of platinum is to be suspended between two forceps in the apparatus represented in vertical section at fig. 1, *a* is a square brass bar, fixed on the wooden stand *b*, and having a binding-screw *c*, at it lower end; upon this bar two sockets *d e*, slide, carrying the arms *f g*, which are terminated by broad forceps, tipped with platinum, and opened or closed by milled screws *h i*. The upper arm *f*, is fixed at the top of the bar *a*, by means of the screw *j*; and the position of the lower arm *g*, is adjusted by turning the nuts *k k*, upon the screwed rod *l*, which passes through the arm *g*: the socket *e*, of the arm *g*, is lined with ivory or other non-conducting substance, to prevent any metallic communication between that arm and the bar *a*. *m*, is the platinum leaf, which is held by the two forceps, and is included in the electric circuit by attaching one of the wires from the battery or other apparatus to the binding-screw *c*, at the bottom of the bar *a*, and the other wire to the binding screw *n*, at the bottom of the rod *l* The current should be one of considerable intensity, and the distance between the forceps should be sufficient to prevent the platinum from being fused. *o*, is a glass shade, which serves to screen the platinum from currents of air, dust, &c

When carbon is used, it becomes necessary, on account of the affinity this substance has for oxygen at a high temperature, to exclude air and moisture from it, which is best effected by inclosing it in a Torricellian vacuum. Fig. 2. is a vertical section of the apparatus employed for this purpose. *a*, is a glass tube, similar to those used for barometers, except that its upper end is enlarged into a cylindrical bulb, and a stout platinum wire sealed in at the top. The upper end of the wire is furnished with a binding screw *b*, and the lower end is screwed into the iron piece *c*, to which the forceps *d*, is attached; the piece *c*, is connected, by a porcelain rod *e*, with a similar piece *f*, that carries the forceps *g*; and the piece of carbon *h*, is held between the forceps *d*, and *g*;—*i*, is a copper wire, which is attached to the piece *f*, and extends to the bottom of the tube. The tube is filled with mercury in the same manner as a barometer (the air being carefully expelled, as usual); its length, independent of the bulb, should be about thirty inches, so that a vacuum will be formed in the bulb when the tube is inverted in a cup of mercury. The instrument is included in the electric circuit by connecting one of the wires from the battery or other apparatus with the binding-screw *b*, and the other with a wire which enters the mercury in the cup at the bottom of the tube. The circuit is thus completed by the column of mercury; and when it is depressed in the tube, by the formation of vapour of mercury in the bulb, the connection is preserved by the wire *i*. That form of carbon found in coal-gas retorts which have been long used, is well suited for the purposes of this invention, and may be worked into the form of small pencils or thin plates, by the aid of the saw and file. As carbon will bear a very high temperature without fusion or volatilization, it may be employed when a very intense light is required.

If an intermitting light be required, for light-houses or other purposes, it may be obtained by breaking the circuit at intervals by clock-work.

When the apparatus is suitably sealed, it may be applied to submarine lighting, and to the illumination of places where it is necessary to guard against the inflammation of highly combustible or explosive compounds, as in powder magazines, mines, &c. When the current is of sufficient intensity, two or more lights may be made in the same circuit; care being taken to regulate the power, by increasing or diminishing the number of armatures (if a magneto-electric machine be employed), or the number of cells (if a voltaic battery be used), so that the united resistance of the strips of platinum or carbon shall be sufficient to prevent the passage of such a quantity of electricity as would destroy them.

The patentee claims the application of continuous metallic and carbon conductors, intensely heated by the passage of a suitably regulated current of electricity, to the purposes of illumination, as above described.

SHIP PROPELLERS.

Thomas Samuel Parlour, of Park road, Holloway, in the county of Middlesex, gentleman, for "*improvements in propelling vessels.*"—Granted November 20, 1845; Enrolled May 20, 1846.

Fig. 1.

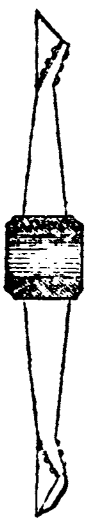
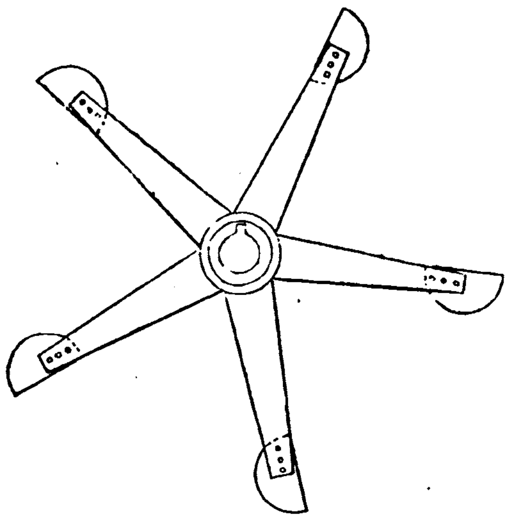


Fig. 2.



The improvements relate to the form of the propeller, fig. 1 is a side view, and fig. 2, a vertical section of the propeller. "The propeller is formed by taking a hollow cone, of sufficient thickness, and cutting it through the vertex at right angles to the plane of its base, so that the two parts may be equal; these are affixed to arms, as represented in the drawing; and these arms are affixed to a boss; which boss has a hole through it, for the purpose of securing it to the shaft. The number of half cones forming the propeller may vary. The angle also of the vertex of the cone may vary; but the most satisfactory results have hitherto been obtained by taking a half-cone, whose angle at the plane of the base was thirty-two degrees. By extending the surface of the half-cone, a greater propelling surface is obtained.

FIRE ENGINES.

John White, of Salford, Lancaster, engineer, for "*certain improvements in engines, machinery, or apparatus for raising and forcing water.*" Granted Nov. 27, 1845; Enrolled May 27, 1846.

This invention is for certain improvements in engines commonly called fire-engines, the object of the inventor being to construct such apparatus with a greater number of pumps of considerably less calibre than those hitherto employed. The mode of arranging the pumps according to this invention is shown at fig. 1, which represents a plan of a fire engine; *a a* is the edge of a circular tank or reservoir, from which the pumps are supplied. This tank is mounted upon wheels in the ordinary manner, to facilitate its removal from place to place; *b b* are force-pumps, twelve in number, each of which is worked with a separate handle *c*, moving upon a fulcrum or fixed axis at *c'*. In the drawing only one handle is shown, which is sufficient to explain the construction of the engine, as each of the pumps are worked in the same manner, namely with a separate handle or lever. The several pumps discharge their contents into the air-vessel *d*, which is fixed in the centre of the machine, and over the air-vessel there is fixed a platform for the firemen to stand upon. We have not thought it necessary to give a sectional elevation of the machine, as it will be evident that each of the pumps must be provided with two valves and a channel or passage leading to the air-vessel and are the same in construction as ordinary force pumps.

The advantages of a fire engine constructed as above are stated to be, that the engine can be worked before a sufficient quantity of men arrive, that is to say, it can be partially worked; another advantage is stated to be that it will be easy to detect those men who are not doing their duty; also, a greater pressure per square inch will be obtained upon the surface of the water; and lastly, the pumps may be worked alternately, whereby a more regular supply of water will be obtained.

Fig. 1.

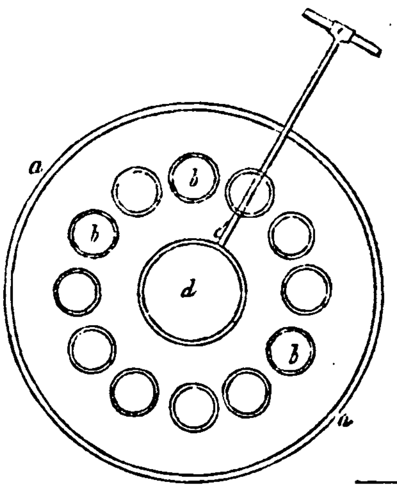
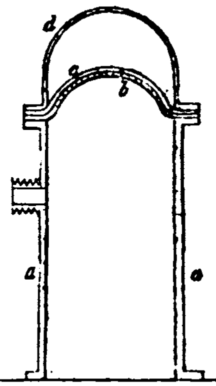


Fig. 2.

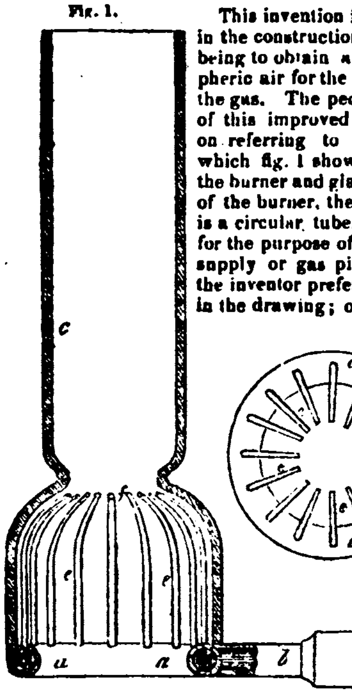


Another part of this invention consists in the construction of air-vessels for regulating the flow of water through the pipe. Fig. 2 shows a sectional elevation of one of these improved vessels, in which *a a* represents the vessel, on the top of which there is a perforated plate *b*, and on the top of this plate there is stretched a piece of vulcanized india-rubber *c*; *d* is an hemispherical vessel forming a cover to the whole, which are firmly bolted together; within this last vessel the inventor proposes to compress atmospheric air to about two atmospheres, or thirty pounds, which forms a resistance or elastic cushion for the water to press against. By this arrangement it will be seen that the water in the aforesaid vessel does not mix with the air; the consequence of which is, that the air cannot pass off from the vessel through the pipe and form the crackling noise which is so frequently heard when working engines of the ordinary construction, the air in the air-vessel being kept entirely distinct from the water.

GAS BURNERS.

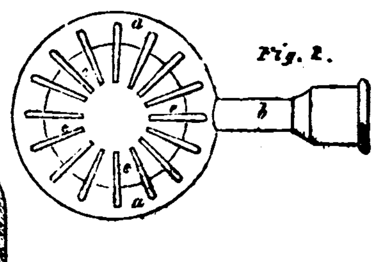
John Leslie, of Conduit-street, Hanover-square, tailor, for "*Improvements in the combustion of gas.*" Granted, Dec. 4, 1845; Enrolled, June 4, 1846.

Fig. 1.



This invention is for certain improvements in the construction of gas burners, the object being to obtain a greater supply of atmospheric air for the more perfect combustion of the gas. The peculiar form or construction of this improved burner will be clearly seen on referring to the annexed drawing, in which fig. 1 shows a sectional elevation of the burner and glass, and fig. 2 is a plan view of the burner, the glass being removed. *a a* is a circular tube, having a branch pipe *b* for the purpose of fixing the burner on the supply or gas pipe; *c* is the glass, which the inventor prefers to be of the form shown in the drawing; on the top side of the circular tube, *a a*, is fixed a number of small bent tubes *e e e*, through which the gas passes, the point of ignition being at *f*, just below the projecting or bent part of the glass, as shown in the drawing.

Fig. 2.

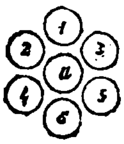


FILTERER.

Josiah Wilkinson, of Lincoln's Inn-fields, gent., for "*certain Improvements in filtering water and other fluids.*" A communication. Granted Dec. 8, 1845; Enrolled June 8, 1846.

This invention consists in a peculiar mode of arranging a series of perforated metal or wooden tubes filled with sponge, animal charcoal, sand, or other suitable material. The mode of constructing this improved filter is as follows:—Fig 1 shows a plan, and fig. 2 an elevation, of a series of

Fig. 1.



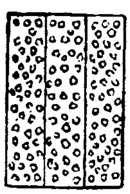
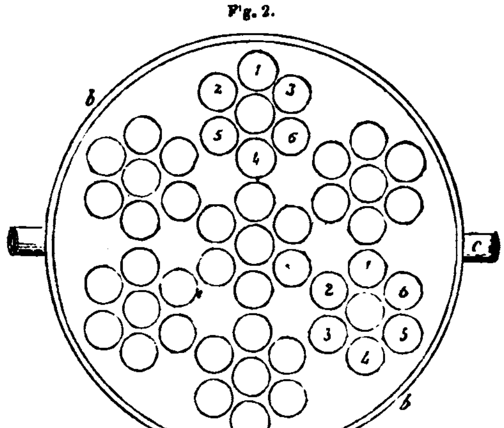


Fig. 2.



perforated metal or other tubes, arranged as shown in the plan, the centre tube *a* being perforated at those parts only which come in contact with the tubes marked 1, 2, 3, 4, 5, 6, so that a communication is formed between the latter tubes and the central one. Each of the tubes, 1, 2, 3, &c., the inventor proposes to fill with sponge, the tube *a* being filled with sand, charcoal, or other suitable filtering matter. Fig. 3 shows a plan of the interior of a filter when complete, which consists of an arrangement of seven groups or series of tubes, as above described, in all, forty-nine tubes, which are enclosed in an outer vessel or case *b b*, having a pipe *c*, leading from a vessel placed in an elevated position and containing the turbid water to be filtered, which, by the hydraulic pressure, is forced through the perforated vessels or tubes 1, 2, 3, 4, 5, 6, containing sponge, into each of the centre tubes, which latter are provided with a branch pipe, leading to an outlet pipe situate above the filter and in the centre thereof, which outlet is common to all. At the lower part of the vessel there is a pipe *d*, provided with a stop-cock, for the purpose of cleaning out the filter, which may be effected by stopping the outlet pipe, opening the stop-cock, and forcing water through it. The inventor, in conclusion, states that he does not confine himself to sponge as a substance to be used in filtering, but afterwards distinctly claims the mode of filtering by means of sponge. He also claims the mode of filtering be hydraulic pressure.

NOTES OF THE MONTH.

It is with extreme regret that we have to record the melancholy death of Mr. Benjamin Robert Haydon, the artist, which took place on Monday, the 22nd ult., at his residence, Burwood-place, Edgware-road. He contributed several valuable articles to this Journal, and to him we were indebted for the interesting extract from Sir Joshua Reynolds' Diary. Next month we will endeavour to collect some information respecting the life and works of this artist.

The *Augsburg Gazette* informs us that Cornelius has completed and exhibited at Rome his cartoon for the mausoleum of the royal family of Prussia. It is made the subject of the following piece of magniloquence—"The cartoon represents the four powers described in the Apocalypse, which are to appear at the end of the world. They ride through the air on horses that seem more intimately connected with them than the centaur with the animal of which he forms a part. In the van is a Tartar chieftain, who sends from his twanging bow-string, like unto Homer's Apollo, the shaft of Pestilence before him. Hunger follows. Corn is so dear that it must be weighed in the scales which he holds on high, while a figure to the left with horrid mimicry proclaims the high price to which all food has risen. Now follows War; a youth of exceeding beauty, swinging the bloody sword of battle above his head, with the united strength of both arms; and lastly comes Death, mowing down all that the others have left him. A chorus of the departed accompany the dreadful host with cries of woe, whose tones seem to sound from out the picture and become audible to the spiritual sense. The tone preserved in this part of the painting is, it is said, indescribably beautiful. Eleven figures, three of whom are children, represent the perishing human race. And yet in this group is contained a representation of all the horrors which the imagination of man can take in at a glance. In more than one figure we see the celebrated motive of Timanthes employed, who, in the sacrifice of Iphigenia, represented Agamemnon veiled. But what is not expressed by the gestures, by the figure of a youth who, amid the agonising struggles of death, covers his eyes with convulsively-closed hands! What name might be given to the suffering expressed on the countenances of the women, who, imploring mercy and pity, fling themselves on their knees before the mighty band! But above all is Anguish, represented with a wonderfully deep knowledge of the human soul in the two little children, invested as they are with a sublime beauty. The young too, the age of innocence, all is unsparingly swept away. Despair is foreign to such tender souls; but in the countenance of the man, who with clasped hands has fallen to the ground, we behold it in all its horror; and this figure forms the centre of the picture." From this description it may be concluded that the German school has exceeded even itself. Cornelius seems to have painted with a thousand horse power, and prepared a rich treat for the admirers of the "intense and convulsive."

A letter from Cairo (May 17), written by an intelligent traveller, informs us that the temple of Dendera had been completely cleared of all the rubbish with which it was encumbered, and was now to be seen as one of the most perfect of the Egyptian temples.

The architects at Hamburgh appear to have imbibed the taste for the chromatic style. Bülan, the architect, in his buildings, does not use stucco, but introduces ornamental bricks of different colours.

A fine mosaic pavement has been discovered in the church of St. Paul, at Nimes. It represents a warrior in his car driving his fiery coursers at full speed, with the body of a man fastened to the tail of the car, and is supposed to represent the triumph of Achilles.

The *Academie des Sciences* at Paris has elected M. Jacobi, of Berlin, one of its foreign members, to supply the loss occasioned by the death of the astronomer, Bessel.

Through the exertions of Sir Stratford Canning, England is likely to possess the treasures discovered by Mr. Austen Layard, at Nimroud. The *Times* gives us the following particulars of these antiquities:—"The discoveries of M. Botta, at Horsabad, are well known to the learned world. Those in which M. Layard is now engaged at Nimroud promise to be much more interesting and extensive. The mound is eight or ten times larger than that which was excavated by the French. It contains the remains of a palace, a part of which, like that at Horsabad, appears to have been burnt. There is a vast series of chambers, all built with marble, and covered with sculptures and inscriptions. The inscriptions are in the cuneiform character, of the class usually termed Babylonian. It is possible that this edifice was built at an epoch prior to the overthrow of the Assyrian empire by the Medes and Babylonians under Cyaxares,—but whether under the first or second Assyrian dynasty is doubtful. Many of the sculptures discovered by Mr. Layard are, even in the smallest details, as sharp and fresh as though they had been chiselled yesterday. Amongst them is a pair of winged lions with human heads, which are about twelve feet high. They form the entrance to a temple. The execution of these two figures is admirable, and gives the highest idea of the knowledge and civilization of the Assyrians. There are many monsters of this kind, lions and bulls. The other reliefs consist of various divinities; some with eagles' heads,—others entirely human, but winged,—with battle-pieces and sieges, as at Horsabad."

A letter from Alexandria states that the barrage of the Nile is proceeding with great vigour, and the men are made to work both night and day in order to take every possible advantage of the present low state of the water. The Pasha's frigates are employed in bringing cargoes of timber from the coast of Caramania; these are immediately squared and sent up to the site of the barrage with all possible speed. 15,000 men, comprising soldiers and country people, are at present employed at the barrage, and, owing to the great fatigue and privations of these poor people, the deaths are very numerous.

The Cathedral of Durham is now undergoing various repairs and restorations. Among other sacred edifices that have suffered by the hand of the despoiler, this venerable cathedral has not been exempt, and any one who visited it a few years ago must have been greatly offended at the disfigurements which would meet his view at almost every step. For some time the Dean and Chapter have devoted themselves to the task of restoring the interior to something like its original beauty. A highly valuable and important restoration is being made in the Chapter-house. When in its original state, the Chapter-house of Durham was justly described as the finest in the kingdom. It was built by Bishop Rufus, 1133-43, and the only subsequent additions were some buttresses at the end, a large perpendicular window above the doorway, formerly full of stained glass and tracery, with stained glass in the east window. Its whole length was 77 feet, width 34 feet 11 inches, and the height at the western arch of the groining 45 feet. The east end was of a semi-circular form, and when in its original state, with its fine columnar work and beautiful tracery, must have been an object of great interest.

On removing the oak stalls from the chancel of St. Mary's church, Nottingham, preparatory to repairing the roof, a sculptured tablet of marble was discovered, buried with its face downwards, which probably has been lying there since the Reformation. It is said to be a spirited and well-executed *bas relief*, consisting of eight figures, and represents the Pope seated on a canopied and elevated throne, consecrating a bishop. Beside the Pope are two cardinals wearing their hats. The bishop is attended by his apparitor, bearing the crozier, and three other attendant figures evaplete the group. The tablet is above two feet in height and one in width, and has been curiously painted and illuminated, the traces of colour being still visible.

Laboratories of the Royal College of Chemistry.—On the 16th of June the first stone of these buildings was laid by Prince Albert on the north side of Hanover-square. The show front of the structure will appear in Oxford-street, and will combine the usual absurdities of modern debased architecture—a rusticated basement and columns hoisted to the first floor. Really there are so many instances of columns thus elevated out of their places, that it is surprising that architects do not now and then, for the sake of mere novelty *alone*, and irrespectively of all sense of propriety, exhibit designs with the columns in their right places.

St. John's Gate, Clerkenwell.—The restoration of this ancient monument is commenced; the owners have consented to case the building with stone and cover the roof with lead. The restitution of the decorative parts is to be effected by public subscription.

Botanic Gardens at Cambridge.—A proposition to levy a small tax on the members of the University, to raise a sum for forming the new Botanic Gardens, has been rejected by the senate.

Booksellers' Provident Institution.—The "Retreat" of the aged and destitute belonging to this institution is progressing; the first portion of the building is nearly finished.

The new College at Galway.—The design selected by the Board of Trade is stated to be that of a magnificent edifice in the style of Henry the Eight's time

Scott's Monument in Edinburgh.—Mr. Steel's colossal statue of Sir Walter Scott will, it is expected, be erected in its place in the monument in Princes-street on the anniversary of Scott's birthday—the 15th of August. In England we have an invariable rule of elevating honorary statues *out of* sight: we trust that our northern neighbours will not disregard this sage and venerable custom.

Victoria Fountain at Brighton.—A new fountain has been erected on the Steyne at a cost of £1000. The design is apparently very unsatisfactory. It has the appearance of being designed by an upholsterer, it is deficient of solidity, and looks as if it were made of zinc or tin bronzed over.

The Brighton and Chichester Railway is now open. The drawbridge over the Arun, described at length in a former number of this Journal, acts quite successfully.

Conversion of the Regent's Canal into a Railway is abandoned, the required amount of capital not having been subscribed.

The Eastern Union Railway is opened. The fares between London and Ipswich are 15s., 10s., and 5s. 8d.

A long-boiler engine of Mr. Stephenson's construction lately ran from Birmingham to Wolverton, 52½ miles, in 70 minutes, drawing 100 tons of goods. At Ackemon bridge, the funnel of the engine was struck down, it being six inches higher than the arch.

FOREIGN NOTES.

Embankment of the bed of the Adige in Tyrol.—The floods of this river have of late caused such damage in the south of the Tyrol, that its embankment has been decided upon—the more important, as its valley is one of the connecting links between Italy and Germany. The court councillor Dassetti has just completed his report, which is accompanied by an instructive lithographed map of the valley of the Adige, from Meran to Boschetta. After the completion of the cut at Ischia Peratti, another more expensive will be commenced at Ischia Lidoruo. The plans for damming up the Noce, one of the most impetuous and mischievous Alpine torrents, are also to be commenced. The expenses will be very great—but only apparently so, as, by the regulation of this mighty Alpine stream, 8,800,000 square klafter (cubits) of boggy land will be restored to its pristine fertility, an equal area preserved from the destroying influence of floods, and the air improved for about 50,000 people, who have, hitherto, constantly suffered from fevers and other diseases inherent in damp localities.

Public Baths on the Continent.—These are now being established very extensively in almost every town. At Amsterdam a huge swimming basin has been laid out on the Y.; at Paris the old established and extensive salle de natation de l'ile St. Louis has been much improved.

General Canal constructions in France.—Never before has any legislative session been taken up by so many subjects relating to constructions, for the improvement of the working classes, &c. The following is extracted from the *Journal des Travaux Publics*,—"The original plan for the maritime canal of Caen is still carried out with energy; 2,800,000 francs have been alone expended in the erection of one of the four walls of the basin, a new bed for the Orme 2,700 mètres long, and the two yettier of Oysterham. Some angry observations have been made on account of the opening of the Orme having cost 800,000 francs, while the original estimates amounted only to 280 000. 1,200,000 francs have been voted for improving the navigation of the Vilaine in the environs of Rennes, comprising earthwork, excavations, aqueducts, bridges, &c. Now a credit of 15,000,000 francs is asked for the completing of the branch canal to the Garonne, between Toulouse and Casteris." The allusions made by M. Adolphe Beaumont to English canals, in the Chamber of Deputies, are not without interest. "In England," said he, "canals give way to railroads. I have spoken in London of our proposed canals, but no one would believe me. The canal from London to Birmingham, which yields 4 per ct. is merely an adventitious exception, because their has sprung up on its banks manufactories, which are its main support. The only remedy against the monopoly of railroads are the railroads themselves. The expense of 15,000,000 of francs for a canal at the present time is an anachronism."

Submarine Vessel.—Some experiments have been, of late, made with a boat constructed after the plan of Dr. Payerne, and called by him *bateaû cloche* (bell-ship). It is made of iron, and to be seen near the Pont Royal at Paris, where it is now moored. On its last experimental trip, eleven persons were on board, and the craft passed (invisibly to the public) through the space between the Pont Royal and that of La Concorde. None of the passengers felt the least inconvenience, although there was a sort of telegraph established for communicating with those above water.

Completion of E. Gerhard's work on Ancient Sculptures hitherto unpublished.—This work, which was formed after those of Winkelman's "Monumenti Inediti," and that of Zoega, has, at length, reached its concluding parts, not without many a sacrifice on the part of the author and publisher. The plates are folio lithographs, the letter-press royal 8vo. They contain a rich harvest of sculptures collected by M. Gerhard in his many peregrinations through Italy. The publication extended over the period from 1828 to 1844. M. Gerhard was one of the contributors to the splendid work on Ancient Rome, in which Chevalier Bunsen also took a share.

Supply of Water to the City of Madrid.—This metropolis is very scantily supplied with water, which the poorer classes have to purchase. An extensive contract (*subasta*) has just been entered upon for supplying it with water for drink and irrigation. The contractor has to furnish the town with 10,000 reals of water (the standard Spanish measure), which is to be available even to the highest parts. The adjudication amounts to the great sum of 71½ millions of reals, and the works are to be completed within the term of two years. If we compare this projected supply with the present which is only 500 reals, it may be easily imagined what a boon will be conferred on the comfort and healthfulness of the humble classes.

The New Post-office of Hamburgh.—The judicious grandeur with which every part of the destroyed city, especially its public edifices, are re-constructed, becomes every day more conspicuous. The Post-office, which combines the *locale* of four especial post departments, erecting after the designs of M. Charles Teauneuf, has next the street a length of 275 feet by a depth of 87 feet, including the courts 27 feet broad. The front is faced with sandstone and ornamented with cornices; has a height of 65 feet above the pavement; the roofs will be covered with thick lead plates. On the east side of the edifice will be erected the new telegraph tower, 150 feet above the pavement, or 169 feet above the average height of the Elbe, not including the signal staff. Immediately below the roof will be the observation room, of an octagon form with a window at each end. The building will include the dwelling of the Director, printing and other offices. The clock will be at an elevation of 150 feet, lighted in the night by a Bude light: each of the two dials will be of the diameter of 6½ feet. All the rooms in the lower story of the Post-office will be vaulted. Besides spacious halls for the public, there will be a general room for those who wish to read their letters. The building will be in some parts three, in other four, stories high, and contain altogether 110 rooms. The paving along the main front will be 17 feet wide.

New Galvanic Telegraph.—German journals speak of a new discovery of M. Leonhard, watchmaker, at Berlin, relating to the above subject. At present, it has been only executed between Berlin and Potsdam, but it is to be prolonged successively to Brandenburg and Magdeburg. The outer form of the machine is simply that of a writing desk; on these, two dials are to be seen. A hand indicates the letter or sign which has been made at the other station. Both machines are connected by metal wire chains, and have been hitherto placed on wooden blocks, but will hereafter be conducted under ground. M. Leonhard is also said to have discovered a new system of railway telegraphs.

The great Danube Docks at Alt-Ofen executed by English Engineers.—The extent of the Danube Steam Navigation Company is such, that they possess at present thirty-seven boats for passengers, and two barges for the conveyance of goods, both combined of 3,926 horse-power. The docks of Alt-Ofen, since they have been under the direction of M. Massjohn, who studied in England, have assumed the shape of a real manufacturing colony. Since 1844 alone, there have been built at this place ten boats of 1306 horse-power. Thirty iron barges, each of the burthen of 5,000 cwt., are in preparation or nearly ready, besides four iron coal barges, and eight for merely conveying pigs and other cattle, one gun-boat for the Austrian government, and twenty moveable piers with the boats appertaining thereto. The establishment is now in a position to manufacture in its own workshop all the requisite parts of a steam boat of from 200 to 250 horse-power, and even all the tools for ship construction, which hitherto they were obliged to obtain from England. The greatest part of the hitherto wooden building has been replaced by M. Massjohn by fire proof structures, and boats and machinery have been much improved. The passenger boats now ascend the Danube from Pesth to Vienna in 18 hours, and from Vienna to Linz in 17 hours,—a considerable saving on former voyages. Boats of 4,000 to 5,000 cwt. burthen do not draw more than 4 feet water, and can, therefore, safely pass over the sand shoals, which formerly much impeded the navigation of this river. M. Massjohn has also established a superior mode of discipline and order amongst the 1,200 men who constantly work at these docks. Still, the Austrian railroads consume a great quantity of iron, which has had the effect, that the above number of steamboats is only half of what would have been otherwise made.

Lately, the dykes around the docks have been heightened for protecting them against the floods, &c. Besides M. Massjohn, both the shipbuilders and chief machinist, Messrs. Pretious and Bissacker are Englishmen.

Supply of Water to the City of Lyons.—It is an inconceivable anomaly that Lyons, situated between two rivers, should have been, hitherto, entirely deficient of an adequate supply of water for its numerous manufacturing and working population. After many sham proposals of projectors and contractors, the Town Council are about to take the subject in their own hands, beginning with a complete canalization of the city, and execute the works on a grand scale, letting the public reap the profit of the undertaking.

Inauguration of French Railways.—The present season is, without doubt, the most important for the many new lines which have been opened in France. On the 8th of June took place that between Paris and Sceaux, a short line, it is true, but one on which the system *Arnoux* has been first tried with sucess. The Great North Line (Lille) has also been opened with great festivities.

Embellishments of Paris.—The great work of a general paving of the Boulevards are nearly completed. The next will be the approach to the bridge de la Concorde and the levelling of the earth which is now in work. The paving of the Place du Carousel will be completely remodelled in a very short time.

Deepest Artesian Well in Europe.—In the Duchy of Luxembourg, a well is being sunk, the depth of which surpasses all others of the kind. Its present depth is 2,336 feet, nearly 984 feet more than that of la Grenelle, near Paris. It is said, that this immense work has been undertaken for working a large stratum of rock salt.

EMBANKMENTS.

Sir—Having been a subscriber to your valuable Journal from its commencement, I have read with considerable interest and profit several of the communications and papers therein. I am at present in search of information respecting the construction of embankments for reservoirs or water dams, in the formation of which there is little or no material to work upon excepting peat or bog earth, and a small portion of clay, with stones sufficient for the formation of 14 inches of breastwork.

I observe in your Journal, vol. 5, page 26, that at a meeting of the Institution of Civil Engineers, on the 29th June, there was read a paper containing a "Description of the Bann Reservoirs, County Down, Ireland," by John Frederick Bateman, M. Inst. C.E.; and also in your Journal, vol 6, page 426, that at a meeting held on the 13th June, a paper was read "On the Formation of Embankments for Reservoirs to retain Water," by Robert Thom, M. Inst. C.E.

I should feel much obliged by your informing me, in your next number, whether either of the above mentioned papers have been published in a separate form, and by whom, or how I can procure a larger knowledge of their contents than is given in your Journal.

Should you have any knowledge of any other treatise on the subject of Water Dams, or can give me any reference to any parties practically acquainted with the subject, I shall esteem it a favour if you will refer me thereto.

I am, Sir, your most obedient servant,

J. B.

Middleton, in Teesdale, June 5, 1846.

The abstracts of Mr. Bateman's paper, and that by Mr. Thom, given in this Journal, contained the whole of the information afforded by the original. No fuller accounts have been published. If our correspondent will send us full particulars of the dimensions and form of his reservoir, we will tell him the pressure the sides will have to resist.

LIST OF NEW PATENTS.

(From Messrs. Robertson's List.)

GRANTED IN ENGLAND FROM MAY 26, 1846, TO JUNE 24, 1846.

Six Months allowed for Enrolment, unless otherwise expressed.

Nathan Defries, of Saint Martin's-lane, engineer, for "Improvements in gas meters."—Sealed May 27.

John Hyde, of Manchester, engineer, for "certain Improvements in looms and apparatus, connected with looms for weaving."—May 27.

Charles Heard de Boissimon, of Leicester-place, in the county of Middlesex, merchant, for "Improvements in manufacturing corks and bungs." (A communication.)—May 27.

John Aston, of Birmingham, for "Improvements in buttons and in ornaments for dress."—May 27.

Alexander Southwood Stocker, of Camden road-villas, gentleman, for "Improvements in the manufacture of bottles and other similar vessels, also in stopping and covering the same, and in the manufacture and application to the whole or part of the articles to be used."—May 27.

John Blyth, of St. Anne, Limehouse, engineer, for "an Improved mode of closing the orifices of bottles or other vessels applicable to inkholders."—May 28.

Richard Marvin, of Portsea, Southampton, gentleman, and William Henry Moore, of Southsea, in the same county, gentleman, for "Improvements in gratings of metal or wood for the fronts of houses and general purposes for the admission of light and ventilation."—May 28.

Henry Seymour Westmacott, of John street, Bedford-row, gentleman, for "an Improvement in the construction of rotatory steam engines."—May 30.

Moses Poole, of the Bill Office, gentleman, for "Improvements in making fabrics from fibrous materials." (A communication.)—June 2.

William Carter Stafford Percy, of Manchester, upholder, for "certain Improvements in the manufacture of bricks, tiles, chimney pots, and other similar articles."—June 2.

Henry Lawrence Tobias Tschudy Von Uster, of the College for Civil Engineers, Putney, for "Improvements in apparatus or machinery for measuring and indicating the distance travelled by wheel carriages."—June 2.

John Webster Cochran, of Paris, engineer, for "certain Improvements in machinery for cutting and shaping wood for ship-building and other purposes."—June 2.

William Stubbs, and John Isaiah Grylls, both of Llanelly, South Wales, engineers, for "Improvements in locomotive and other engines and carriages."—June 2.

Joseph Clinton Robertson, of Fleet street, London, civil engineer, for "certain Improvements in railways and railway carriages." (A communication.)—June 4.

George Lowe, of Finsbury-circus, civil engineer, of an extension of a patent for the term of five years, from the 8th June, 1848, for increasing the illuminating power of such coal gas as is usually produced in gas works, also for converting the refuse products from the manufacture of coal gas into an article of commerce not heretofore produced therefrom, and also of a new mode of conducting the process of condensation in the manufacture of gas for illumination."—June 4.

John Taylor, of Carlisle, miller, for "certain Improvements in flour mills, and in machinery connected therewith."—June 6.

Robert Rettie, of Glasgow, civil engineer, for "certain Improvements in the manufacture of fuel, parts of which improvements are applicable for the purposes of purifying, compressing, or extracting vegetable and other substances, and fluids, and in the machinery or apparatus to be used for the same."—June 12.

Edward Cottam, of St. John's-wood, for "Improvements in bedsteads."—June 16.

Frederic Handell Burkinyoung, of Baker street, Middlesex, gentleman, for "Improvements in piano fortes."—June 16.

Benjamin Fothergill, of Manchester, machine-maker, and Richard Johnson, of Clitheroe, in the same county, cotton-spinner, for improvements in certain parts of machinery used in the preparation for spinning, and in the spinning and doubling of cotton, wool, and other fibrous substances."—June 16.

Robert Reyburn, of Brown-street, Glasgow, chemist, for "Improvements in making extracts from animal and vegetable substances."—June 17.

William Cormack, of Thames-street, Greenwich, chemist, for "Improvements in obtaining motive power."—June 17.

Alfred Richard Johnson, of the firm of Messrs. Johnson and Co., of Regent-street, and Messrs. Griffiths and Johnson, of Old Bond-street, hatters, for "certain Improvements in hats, caps, and bonnets"—June 18.

John Simson, of Riches court, Lime-street, merchant, for "certain Improvements in machinery for preparing and spinning flax, and other fibrous materials."—June 20.

Henry Austin and Thomas Webster Rammell, of 10, Walbrook, City, civil engineer, for "Improvements in wood, mosaic, and tessellated work."—June 22.

Spencer Thomas Garrett, of Cliff-bank Lodge, Stoke-upon-Trent, Esq., for "certain Improvements in cements, bricks, tiles, quarries, slabs, and artificial stones."—June 22.

Bennet Woodcroft, of Manchester, consulting engineer, for "an Improved mode of printing certain colours in calico and other fabrics."—June 22.

Thomas Walker, of Birmingham, stove-maker, for "Improvements in ships'-logs and in sounding machines."—June 22.

John Mercer, of Oakenshaw, chemist, and John Greenwood, of Church, in the same county chemist, for "certain Improvements in dyeing and printing Turkey red, and other colours."—June 22.

William Mathers Hall, of Leeds, brass-founder, for "a certain improvement, or certain improvements in, and applicable to sliding gas pendants, lamps, lustres, and chandeliers."—June 22.

Joseph Renshaw, of Salford, Lancashire, mechanic, for "certain Improvements in machinery, or apparatus, for finishing velvets and other piled goods or fabrics."—June 22.

William Cotton, of Loughborough, manufacturer, for "certain Improvements in knitting machinery."—June 22.

John Gillett, of Brailes, Warwick, agricultural implement maker, for "an Improved apparatus for protecting property by sounding alarums, or giving signals."—

Joseph George, of Chelsea, Middlesex, coal and twine master, for "Improvements in the construction of houses, buildings, and other erections."—June 22.

Thomas Jones, of Salford, Lancaster, machine-maker, for "certain Improvements in machinery or apparatus for preparing, slubbing, and roving cotton, wool, and other fibrous materials."—June 22.

William Topling Nesham, of the London Docks, engineer, for "certain Improvements in the apparatus and mode of applying power for raising and lowering weights or heavy bodies."—June 22.

Ambrose Lord, of Allerton, Cheshire, toll-collector, for "certain Improvements in furnaces and the flues of steam-boilers, for the purposes of consuming the smoke and economising the fuel."—June 24.

CORRESPONDENTS.

J. M.—The abstracts of the proceedings of the Institution of Civil Engineers which appear in the weekly periodicals are generally of too popular a character to be of much value to the professional engineer. By the courtesy of the Institution we have been hitherto supplied with an official account of the proceedings, but owing to some unexplained delay, the publication of the papers of the present Session has not yet been commenced and consequently we are deprived of our usual source of information. It is really of no use in a work making any pretensions to philosophical accuracy to give any but *authentic* reports. For example, a long paper has recently been read at the Institution, by Mr. W. Harding, on resistances to Railway Trains. The only part of his conclusions which *is at all new*, is what he calls "resistance from concussion;" we therefore naturally wished to confine our attention to this part of his paper, but on turning to the reports in the weekly publications, we can find neither an explanation of what is meant by the phrase "resistance from concussion," nor any account of the reasons for adopting the expression "$\frac{1}{2}$ V" as the measure of this resistance.

A Working Mechanic, and J. B. will be answered next month.

THE FUTURE DEVELOPMENT OF MEDIÆVAL ARCHITECTURE.

Modern ecclesiology is the revived study of a neglected branch of human knowledge; and like all similar revivals compensates for previous neglect by present enthusiasm. It is by no means an uncommon occurrence in the history of literature and art that a zeal for reproduction and servile imitation should suddenly spring up which threatens, at first, to destroy not only all hope, but even all desire of originality.

These indications, so prejudicial to the true interests of art are however transitory—at least they have always hitherto proved so, as far as we are acquainted with intellectual history, and we may safely hope that they will be so with respect to the modern study of Mediæval architecture. While the first impulse and freshness of the novel pursuit lasts, all attempt to gain a characteristic individuality is sacrificed to an unthinking and undiscriminating admiration of the ancient models; but after a while the votaries of the new science become weary (and perhaps a little ashamed) of being mere copyists, they find for the first time that all the features of their idol are not admirable alike, that some parts are far more worthy of study than others, and then finally, if they themselves possess creative power, adopt those parts, not as patterns, but as so many hints—way-marks, as it were—of the direction in which their own genius may most successfully pursue its course. Just in the same way—the greatest orators, writers, sculptors, and painters have been content to be for a time disciples of ancient masters, in order that they might form their own style on the classical models, of which their creative genius forbad them from copying the actual ideas or modes of expression.

In accordance with these considerations it becomes a matter of great practical importance to ascertain exactly the degree and nature of the admiration with which we should regard Mediæval art, to discriminate between its merits and defects, and above all to determine which of its numerous varieties or styles are most worthy of being studied with a view to further development. We by no means claim the merit of originating this investigation, it has already been pursued to a considerable extent by others, although the conclusions at which they have arrived are extremely various.

One class of writers, who represent a considerable portion of the English students of Mediæval architecture, recommend the exclusive adoption of the second great style of Pointed Architecture, commonly known as the Decorated, which, to use their own peculiar mode of expression, "is the style of Pointed Architecture which we consider to have the most nearly approached perfection, or, as we should more truly say, the furthest departed from imperfection. It was but an approach, and but for an instant, it just unveiled to men a distant glimpse of heavenly things and dazzled his [their] poor eyes with that imperfect vision." Another class of writers describe Perpendicular as the most perfect style of Pointed Architecture, but recommend Romanesque for exclusive adoption in building new churches, as being the most suitable for modern purposes.

These contending opinions represent, we believe, with tolerable accuracy the respective views of two bodies who have rendered themselves celebrated by the zeal with which they pursue the study of church architecture—the Oxford Architectural Society, and the Cambridge Camden or Ecclesiological Society; and seeing, as it is impossible not to see, that these two bodies have promulgated, among much which is inconsistent, and much which is controvertible, a large mass of sound and valuable information respecting Pointed architecture, it is useless to treat their opinions with indifference.

We are very anxious to contribute to the attainment of a sound conclusion as to which of the styles of Mediæval architecture should be preferred, but in stating the views and arguments of the two Academical bodies mentioned, we are met by this difficulty, that the discussion has been made to assume a theological character, which renders it in a great measure unsuitable for these pages. The advocates of one or other of the various styles of Mediæval architecture do not rest the claims of either merely on its intrinsic beauty or constructive value, but chiefly on its typical reference, or supposed reference to religious doctrines. For the completeness of our argument it will be necessary to allude in general terms to the latter class of arguments, and show that even if we allow to them the weight given by their authors, they are still so nearly balanced as to leave the main question unaffected.

It is indisputable that during the middle ages there was a tendency to establish resemblances between material forms and abstract ideas. This tendency may probably have arisen from the prevalence of monastic institutions; for in the vacuity of thought unavoidable in a state of monotonous seclusion, the mind must either be occupied by some fanciful unreal employments, or become enfeebled by pure inaction. (And it may be remarked in passing that this consideration is a reasonable explanation of the fact that symbolic speculations are in our times most rife among academical and cathedral bodies, wherein the manner of life most nearly resembles ancient monachism.) These speculations were anciently applied to all the sciences—chemistry was neglected for alchemy, astronomy for astrology. The study of botany became a mere collection of comparisons between flowers and church festivals—the snow-drop and Candlemas, the daffodil and the Annunciation, the ranunculus and the Invention of the Cross, the white lily and the Visitation of our Lady, &c., the passion flower being however the favourite subject of this species of mental indulgence. To the same source must be attributed the cabalastic interpretation of mysterious numbers, and lines on the human hand, the black art and the whole cycle of occult sciences. The whole material and intellectual world were arranged in a universal system of type and antitype; and all things visible were supposed capable of a recondite symbolic interpretation. The Germans in modern times have somewhat refined on this method of double-signification by their system of exoteric and esoteric ideas, that is, in simple English—the system of saying one thing and meaning another.

It is easy to suppose that in the Mediæval times the love of symbolism would be frequently exhibited in architecture, and as a matter of fact there is no doubt that it frequently was so exhibited. For to what other cause can we assign the cruciformity of churches, the position of the font near the entrance, and orientation or the position of the chancel at the eastern end? Occasionally the symbolism seems to have been carried into minute particulars, and affords a curious reflex of the mind of the architect, for it is generally observable that where these indications of trivial resemblances exist, the architecture is of a feeble character, and does not exhibit that boldness and vigour of conception which belong to a vigorous masculine intellect.

But that symbolism of every kind, whether minute or general, depended on the individual caprice of the architect, and not upon any accepted law of church architecture, is evident from the partial manner in which it is exhibited. Taking all Christendom through, the number of churches with cross transepts is far exceeded by those of which the plan is rectangular or irregular. In the same way the orientation has been as frequently disregarded as observed; in continental churches especially, the disregard of orientation was so great that in one church the chancel is sometimes nearly opposite in direction to the chancel in a neighbouring church. Of the position of fonts it is not so easy to speak, because, being moved with tolerable facility, they have been frequently displaced from their original situation. Another architectural form, which has been supposed to bear an obvious symbolic meaning, the eastern triplet window, is by no means of universal occurrence: in every successive style of church architecture there are numerous examples of other kinds of windows at the east end of the church. And it is important to observe also that the Mediæval architects were by no means jealous of restricting to ecclesiastical uses the forms which are capable of a symbolic interpretation, for the triplet window is commonly found in edifices constructed for secular purposes.

That the general affectation of analogies and fanciful conceits which prevailed in the middle ages should be occasionally displayed in architecture was naturally to be expected—that it should be universally displayed was practically impossible. And this reason, if no other existed, would have sufficed to prevent symbolism becoming a positive law of church building. If for instance it had been determined that one essential requisite in the construction of a church was that the plan of the building should typify the doctrine of the Cross, if this kind of teaching were considered a religious necessity, then it is evident that a church without transepts must exhibit some other kind of teaching, that it must inculcate a heresy, and that the worshippers in it must be heretics. It would however be frequently necessary to build churches where it was physically impossible that the plan should be cruciform. This necessity alone would prevent symbolism from assuming the sanction of universal custom; for it is to be observed, greatly to the credit of the Mediæval architects, that they never sacrificed real palpable advantages for the gratification of their speculative prejudices—that their minds constantly exhibited a practical tendency entirely unknown to or unappreciated by those who now ape their idiosyncrasies.

We trust that the reader will perceive in the sequel that our argument on the point before us has not been unnecessarily minute, for the whole question of the future development of Mediæval architecture depends upon it. If those who assume the office of pronouncing publicly on the merits of modern church architects ground their criticisms on speculative doctrines, such as those here alluded to, it becomes the direct interest of architects to ascertain how far those doctrines are correct.

What seems a fatal objection to doctrinal instruction by the aid of material forms is, that the system never did and never can become general, and moreover that if it could, it would never be free from ambiguity. This kind of teaching must belong to one or the other of two classes—suggestive or conventional: that is to say, the forms in which it is embodied must be either suggestive of their intention, or if they bear no outward resemblance to the thing typified, their signification must be purely arbitrary. To the first of these classes belong cruciformity and orientation which as we have shown are liable to the objection of want of generality, because occasionally they would from local circumstances become practically impossibilities. In the same class of suggestive symbols must be ranked the eastern triplet: a species of symbolism which makes out a case stronger even than that derived from the two former species. In the case of the eastern triplet the deviation from the general rule (if such rule existed) was perfectly gratuitous and unwarranted by necessity: for it is impossible to suppose that the architect was ever practically compelled by local requirements to build a window of five or seven lights in preference to a triple window. What then shall we say of a conventual church like that of Jesus College, Cambridge, for example? Were the worshippers polytheists? They must have been so if they derived a symbolical teaching from the eastern window.

The argument respecting ambiguity applies with equal force. If the eastern triplet consisted of three separate and distinct windows, then it taught a heresy, and if the centre window were larger and more important than the rest, it taught another heresy. The nature of these heresies need not be here specified, they are both denounced in the *Quicunque vult*, in the expression "una est divinitas, œqualis gloria."

But the ambiguity would become absolutely inextricable confusion when forms possessing similar peculiarities were made to represent different doctrines. For instance, if anything like system and distinctness were to be maintained, it would be obviously necessary that all forms of which the most distinguishing mark was their triplicity, should suggest one and the same doctrine. The fleur-de-lys, for instance, three component parts united by a band, ought to teach the same thing as the eastern triplet embraced by one hood moulding. The fleur-de-lys however teaches something altogether different. It has, says the *Ecclesiologist*, "from the twelfth century at least, probably for ages long anterior, been the recognized emblem of the Virgin Mother as such." We must beg the reader to take notice of the words "recognized emblem," because we will show by another quotation from the same place how far the emblem actually was recognized. The reason of its being "appropriated as an ornament to the seats of the Laity in particular," was that it suggested what was peculiarly "the peoples' doctrine." Now then how far did the people understand the suggestion? We are told that the popular name of this ornament (*popie*) was derived from its supposed resemblance to a bundle of hemp. The old church-designers had however "something more significant in view than the mere giving of an ornamental finish to an otherwise plain seat-end. Nor had they any intention of imitating 'bundles' of hemp or of any other substance: *that was a mere fancy of the workmen.*" It appears therefore that whatever may have been the *intention* of the designers, it failed of its effect. The workmen misunderstood the meaning intended, and the people generally committed the same error, for the name "popie" seems to have been a popular one, and the result of a vulgar error similar to that by which "Pan and his Bacchanals" was corrupted into "the devil and his bag o' nails," which was a common sign of old inns.

So much for the efficacy of symbolic teaching, where the form of the symbol was suggestive: with purely conventional symbols the matter must have been still worse; for here even the *memoria technica*, which afforded some little help in the former case was wanting. To understand at all the meaning of the types, constant reference must be had to a written code, like that now used in the navy for interpreting signals made by flags or rockets. Such a code has been compiled by Durandus, though never authoritatively recognized. We confess, without much shame, that we know as little of this work as we do of the "Aurea Legenda," or Butler's marvellous "Lives of the Saints," and that little is obtained from merely meeting with a few occasional extracts. Still, we apprehend, the great body of the people, in the most flourishing times of the unreformed church, were in the same state of lamentable ignorance. At least we are certain they are at present, and that there would be some slight difficulty in getting them to read Durandus now,—if they did not, really we cannot see what the use of the symbols would be. It would become the case of the rockets without the signal book.

But suppose the difficulty removed. Suppose the people *were* at last got to study Durandus (which by-the-by seems as likely as that the inhabitants of St. Giles's should take it into their heads to commit the Nautical Almanack to memory), would not the labour of teaching be twice as great as that required by a more direct method? First the forms are to be learned, then the code of interpretation has to be "got up," then the application of the interpretations. But why go by such a circuitous route? We are convinced the thing would never answer. Among so many scholars with very different degrees of desire and aptitude for learning, so many mistakes would occur that we should soon have to revert to the more direct process. Complicated machinery is seldom successful in practice.

But there remains another argument for symbolism, one derived from mere architectural considerations, and not connected with theological doctrines. It is this, that symbolism is a source of the beautiful—that truth and beauty are so nearly allied, that material representations of truth must exhibit beautiful forms. This is one of those showy sentiments which entrap unwary readers, especially if they have a taste for magniloquence. But what is the fact? The beauty of the symbol depends, not on the nature of the truth symbolized, but on the method of representation adopted by the artist. If the artist have taste and genius the symbol may be beautiful, if not, the symbol will most likely be absurd and ugly. The restriction put upon the designer that the forms adopted by him shall typify abstract ideas, will add so much to the difficulty of his task, as to have in all probability the very reverse of a beneficial tendency. The design instead of being improved (as it is argued) by symbolism, will most likely be greatly injured: unless we suppose that the desire of symbolizing religious truth will necessarily be accompanied by the faculty for doing it in a graceful manner—which is much the same thing as supposing that every religious person is *ipso facto* imbued with good taste. We will not cite examples to the contrary,* but we may at least mention one or two instances which disprove the converse proposition, namely, that men imbued with good taste are *ipso facto* religious. Material beauty is far better represented in the paintings of Salvator Rosa, and Raphael, than moral beauty in their lives and conversation.

There seem therefore no reasons (except those which fanatacism would suggest) why ecclesiastical symbolism should be more beautiful than any other. The Chinese characters are a kind of symbolism, for they originated in the representation of natural objects by conventional forms, so did Egyptian hieroglyphics, so did our own heraldic devices. Is there any thing of beauty or propriety in these forms? We fail of discerning the gracefulness of a rampant spare-waisted unicorn, or a double-headed dragon covered though they be with Mediæval rust, and honestly confess that we prefer the Elgin marbles.

We have alluded in another place to the significant symbolism of skulls, cross-bones, and chains, which decorate the front of Newgate gaol, as a proof that symbolic architecture is not always beautiful, but we have not spoken yet of the profanity and indecency occasionally exhibited by Mediæval symbols and grotesque carvings. The sculpture of the Hotel-de-Ville of Louvain, for example, representing the mortal sins and their punishment, displays forms revolting to any but the foulest imagination. Again, the constant collocation of serious and ridiculous subjects sanctioned by Mediæval architects would be deemed intolerable now. We have seen in an old continent churches an absurd representation of a monk with his toe in his mouth, &c. These and similar extravagances might be permitted in

* Yet we may be allowed under this head to remind the Ecclesiologist of the fact mentioned by our cotemporary, that Archbishop Laud (the theme and admiration of all ritualists) caused Inigo Jones to disfigure one of the noblest of our Cathedrals, old St. Paul's, with a detestable Corinthian portico.

the time of the ancient "moralities" or "mysteries," religious dramas in which the Divine names were freely introduced among the *dramatis personæ*, but no amount of precedent would suffice for their revival now. If there be one instance more striking than another of the necessity of distinguishing between the valuable and the valueless parts of Mediæval art, it is this of grotesque or monstrous devices. Nothing which is unnatural can be beautiful, for nature is the source of all ideas of beautiful forms—the heraldic monsters of the new Palace at Westminster, the hideous encaustic tiles recently laid in the Temple Church, and if we remember rightly, similar modern absurdities in the Round Church at Cambridge, are no better than simious displays of the faculty of imitation.

Symbols such as these will never probably be ranked in serious argument among the valuable parts of Mediæval architecture. But there remains yet another class to be alluded to which may be termed historic symbols, symbols employed in church architecture to represent not doctrines which are true through all ages, but current facts of ecclesiastical history. We are not certain that this distinction was really made by ancient architects, but notice it because it is laid down by Durandus, and adopted by modern ecclesiologists. To take an instance—

"It is well known that all Mediæval cathedrals either do now or did formerly contain stalls in their choirs: we know also that in the primitive basilcs there were no stalls in the choirs, but that the Divine offices were sung standing. We know from history that stalls were not introduced without a struggle. They however became a "fact," (to use a much abused word), and what does Durandus say of them? 'The stalls in the church signify the contemplative.' . . . . . Truly the contemplative life in a healthy state of churchmanship is a most fit vocation for the canons of a cathedral-church, and it is certainly not very hard in this case to discern the analogy between type and antitype. But suppose a vast increase of Bishops to be made in England under an improved state of churchmanship and cathedrals to be built in our poor and teeming trading and manufacturing town—Liverpool for instance and Sheffield—charity and common sense would dictate that the canons of these cathedrals would have a very different vocation from their brethren at Lichfield or Ely; that they would have in the strictest sense of the word to do the work of Evangelists; that they have to go forth as *preachers of the very first rudiments of religion to a virtually heathen population*. Contemplation therefore to them must be a recreation not an occupation, and the symbolism that should point them out as contemplatives *would not be borne out by facts* . . The canon of the symbolism of choirs would then be embodied in the following form:—In some churches are found stalls. These stalls signify contemplation, &c. (as in Durandus). In other churches built in large towns to serve as missionary stations, there are no stalls, but there the Divine office is performed standing.* These choirs signify wretchedness as it is said in the Prophet, 'How beautiful upon the mountains are the feet of him that bringeth glad tidings.'

"We have, we trust, sufficiently vindicated the truthfulness of that minute system of symbolism which is found in the writings of Durandus and other authors of the middle ages"!!—*Ecclesiologist*, p. 226.

After the reader has carefully perused this extract and noticed the passages which we have marked in italics, let him reflect on the result likely to follow from the system here impliedly recommended. How much gratified the good people of Liverpool and Sheffield would feel to have cathedrals on the terms suggested! To be reminded continually by visible signs that they, in contradistinction to the people of Ely, are heathen idolaters! The proposition forcibly reminds us of Sydney Smith's celebrated selections from the Evangelical Magazine—"Christianity introduced into the parish of Lanston, near Bicester in 1807." "Chapels opened—Hambleton Bucks—eighteen months ago this parish was destitute of the Gospel: the people now have one of the Rev. G. Collison's students," &c.

But the principal consideration in an architectural point of view is this—we are told in the extract before us, that the kind of symbolism which would be appropriate to a particular church at one time, at another "would not be borne out by facts." How then shall the species of symbolism be appropriate to each locality be decided upon? Who will undertake the delicate task? And for localities halfway between the heathenism of Sheffield and the godliness of Ely, what intermediate system of symbolism shall be adopted? Who will invent a finely gratuated scale of symbolism which will exactly suit all the variations of that spiritual thermometer of which Ely and Sheffield are boiling point, and zero respectively? And when Sheffield has begun to improve—when the influence of the standing canons has begun to tell upon the people—when the original symbolism is no longer "borne out by facts," who is to make the alteration, and how is to be ascertained the exact moment for making it?

We are told that the main object of symbolism is not so much to teach religion, as to honour it. We will not stop to prove that the system here advocated would lead to the grossest materialism and dishonour religion by making it appear ridiculous; it is enough for us to show that the scheme is impracticable. It would be beyond the collective wisdom of the Cambridge Camden Society, it would be beyond the compass of all human sagacity and invention to overcome the practical difficulties here mentioned. If the system were a mutable one—true at one time and not true at another, then it, or at least the mutable portion of it, even though we wave all dispute as to its actual merits, must yield to the fatal objection of its impracticability.

A large proportion of the whole number of church symbols, namely, the historic class is thus disposed of. Respecting the remainder, those symbols which refer to immutable truths, we may be certain that the greatest part, like the "popies" aforesaid, would be the subjects of vulgar perversions, which would render them useless if no worse. The representation of abstract truths by material forms is difficult enough even when those forms are the 26 letters of the alphabet combined into words and sentences. If the greatest of philosophers and divines have found all the resources of written language scarcely sufficient for the perpicuous explanation of their thoughts, if the church herself have been unable to express her articles and rubrics with a distinctness which would place them beyond insidious misrepresentations and additions, what shall we say of the difficulty of expressing the same abstruse doctrines by the unyielding form of architecture? To every unprejudiced mind it must be obvious that bricks and stones, however contorted, could never answer the purpose effectually, that the architecture must become a congeries of hideous and absurd devices, and above all, that where honour and reverence were intended vulgar ridicule and desecration must infallibly ensue. This consideration disposes of the second sort of symbols; and so the whole delusion melts into air—thin air.

To some of our readers we may perhaps appear to have been unnecessarily minute in the arguments by which we arrive at this conclusion. There are some who would have us treat church symbolism as an obvious absurdity, not worth arguing about: and the whole doctrine is doubtless one which might easily be made the subject of sarcasm and ridicule, but we have been careful to view every part of the question seriously and patiently, because upon the due settlement of it greatly depends the future development of Mediæval architecture. The principal arguments brought forward by those who advocate the exclusive adoption of the Decorated style are founded on symbolic considerations; those who would adopt Romanesque exclusively rest their case *entirely* on the supposed doctrinal interpretation of the prevailing forms of that style. Having then explained to the best of our power the grounds on which we would exclude from the question of the future development all symbolic considerations, we shall have less difficulty in discussing the remaining part of the question, namely, the purely architectural considerations.

To begin with the consideration of the architectural value of Romanesque or Norman architecture, our own opinion is decidedly against any very general re-adoption of that style. It is essentially imperfect in its general character and individual details. It is a transition style—not a transition from one of two congruous modes to the other—but a transition from the Classic mode to another in every way antagonistic to it, the Pointed. Romanesque constantly exhibits traces of the effort frequently made in Roman, namely, that of reconciling two directly opposite and irreconcileable modes of construction, TRABEATION or construction by straight beams, and ARCUATION or construction by arches. Every transitional or mixed style must of necessity be incomplete: and for this reason a great objection will always exist against the revival of Romanesque. It does not however follow that because it is an incomplete style that it is absolutely valueless. It is an important rule of criticism that a work of art may have beauty and yet not be perfectly beautiful. Now this we apprehend is precisely the case with Romanesque architecture; the very effort to combine two incongruous modes was the source of beauties which belong exclusively to this faulty but effective style. The enormous massive pillars and walls are evidences

* We have already noticed the circumstance that the writers here quoted do not consider it always imperative to observe the ordinary rules of English composition. In the expression "the Divine office is performed standing," the participle "standing" should by the principles of Syntax refer to the preceding noun "office;" the meaning is however, not that the Divine office stands—which is nonsense—but (we presume) that the canons stand when the Divine office is performed.

of imperfect knowledge of construction. Had the Normans possessed the constructional skill of later architects, had their knowledge of mechanics enabled them to construct a spire with the magical appearance of lightness which belongs to the Strasburg spire, they would certainly have availed themselves of that knowledge. Modern ecclesiologists tell us that the Normans built massively and imperfectly, because their mode of contruction typified the state of the church in their own times. The reason which we should assign is far too simple and unsophisticated to find much favour in the Universities, but we are disposed to think that if the Normans did not build with the symmetry and graceful proportions which distinguish later architects, it was simply because they could not.

Romanesque, like all mixed architecture (cinque cento for instance) abounds in surface decorations. For the reason of this circumstance we need not look far. A style which combines incongruous modes of construction must afford means for masking the inconsistency: and accordingly we find in Italian and Romanesque, and every other impure kind of architecture, that the construction is never clearly exhibited, the decorations do not arise naturally from the constructive arrangements, and that the architect is compelled to resort to surface ornaments as alternative expedients for producing variety. The arches of decoration which characterise Romanesque towers, &c. are examples of these inconstructive ornaments.

A practical objection to the general adoption of Romanesque—an objection which perhaps will weigh more with the professional than the amateur architect—is that it is a very expensive style. The modern kickshaw Romanesque structures with thin walls and slender pillars are not very costly; but we speak here of real Romanesque—not of a mongrel architecture which mimics the details of that style without possessing the least portion of its spirit. The characteristic solidity and massiveness of Romanesque masonry can seldom be reproduced in modern times. Besides, it is poor affectation to copy defects—to return to imperfect modes of construction when we possess more perfect modes.

The advocates of Decorated architecture are not quite so exclusive as the advocates of Romanesque. It is true that the former usually condemn new churches built in any style but their favourite one; they admit however the merits of other styles. "Will it be maintained," say they, "that though Middle Pointed be as a whole more perfect than First Pointed, yet that there are not parts and details in the latter more perfect than in the former, and that it is *primâ facie* clear that there can be no absolute impossibility in engrafting them upon Middle Pointed? Therefore any style which shall combine them with the mass of Middle Pointed must be a more perfect form of architecture than has yet been produced. We admire the smooth flowing delicate sweep of a Middle Pointed moulding, still we cannot but desiderate the wonderful boldness, the solemn depth of light and shade in a mass of First Pointed mouldings. . . . . Again, we will be bold to say, why should not back surfaces and splays display that prodigal variety of surface ornament which is the distinguishing embellishment of Romanesque?"

This question appears to us capable of a satisfactory answer. The attempt to combine two different styles has always failed—always will fail—because it destroys the individuality of both. This necessity of characteristic physiognomy is quite independent of intrinsic beauty, and is much overlooked in modern art. The artist who endeavours to give a water-colour painting the effect of oil colours—the musician who would impart to the violin the peculiar ictus of the piano or intonation of the organ—the sculptor who by piercing the eyes of his statues borrows the effects of colour, entertains, we hold, defective notions of the true purposes of art. Each of these combinations is made at the sacrifice, so to speak, of identity. The mixed result instead of preserving the merits of both its archetypes usually injures both.

To view the subject historically—had not the architects of the Decorated Period fully as many opportunities of combining with their own architecture, the characteristics of the previous period as we have? The very fact that they did not avail themselves of these opportunities is a strong presumptive argument against the expediency of making the attempt now. We see, as the second great style of Mediæval architecture approached perfection, the characteristics of the first style, one after another, voluntarily relinquished. The deep undercut mouldings of Early English, the exquisite lancet windows with detached shafts, &c., fell into disuse. Can we imagine that men who showed such a thorough appreciation of the beautiful as did the architects of the Decorated period, would have given up forms of so much beauty wantonly, and without they had entertained a fixed purpose for which those forms were incompatible? If we examine an Early English church or a Decorated church separately, we shall find that the details of each are exactly consistent with the general character of the building. And this observation applies not only to the actual forms but the modes in which those forms are applied. In Early English some parts are elaborately ornamented, which in Decorated were left plain. It is difficult to explain these characteristics by verbal description, but we feel convinced that the architectural reader who has become familiar with them, by actual observation, will bear us out in the assertion that the character of each style so thoroughly prevades every portion of it, and is so strongly marked in its minutest details, that the attempt to transfer parts of one style to another must produce confusion.

This unsatisfactory result may be partially traced in the transition styles of each period. It cannot be denied that the monuments of transition architecture are usually very interesting, and that their prodigal display of rich embellishments elicits the highest admiration. But these buildings seldom have a distinct character of their own. They are, as it were, borderers on the confines of two countries, and exhibit some of the good and bad qualities of both, without possessing the nationality of either.

The remainder of our space must be devoted to the defence of Perpendicular architecture from the obloquy to which it has been subjected. The principal objection urged against this style is that it is not symbolic. We do not consider it necessary to resume the discussion; we shall merely make one observation with respect to the absence of the Triforium. The symbolists protest against the disuse of a feature which, with the clerestory above and the arcade below it, constitutes the triplicity which they love to trace in every part of a sacred edifice. To ourselves, however, a sufficient argument against the re-adoption of Triforia is that they are useless. In the unreformed Church they appear to have served as galleries from which were hung draperies on high festivals. It is clear that they could never be applied to such purposes in modern English churches, and it must or ought to follow thence, that all who advocate faithfulness in architecture must object to the introduction of members which are not merely useless but fictitious also, from assuming an appearance of utility which does not really belong to them.

The objection that the mullions of Perpendicular windows are inconstructive has but little weight, for it applies to all mullions whatever, whether they meet the soffit of the arch vertically or obliquely. Any one who is acquainted with the mechanical properties of an arch knows that it ought to be supported on its abutments only—that it does not require support from intermediate props. If, then, such props be applied either by the vertical mullions of Perpendicular windows or by the curved tracery of Decorated windows, these additional members are *alike* inconstructive; and *quoad hoc* the Lancet style is more constructive than either of the other two. But it would be impossible to fetter art by these minute restrictions. If a comparison be established between two styles to ascertain which is the most constructional, it is not the *ornamental* details, but those larger parts to which the building owes its stability, which should be compared.

Viewed in this manner, we have no hesitation in saying that Perpendicular is the most constructional of all the styles of Pointed architecture. Its very name implies as much. It might be pronounced *a priori* that a style distinguished by continuous vertical lines would afford the most convenient bearings for sustaining superincumbent weights, and would therefore be the most useful for lofty buildings. Accordingly, we find vertical shafts, such as those which run up between the windows of King's College Chapel, from the ground to the vaulting, support the roof more directly, and therefore more efficiently, than do the clerestory walls of a Decorated church. At all events, it cannot be disputed that the construction is more apparent in the former case.

Vaulted roofs appear more consistent with Pointed architecture than wooden roofs, because the construction of the latter is usually of the kind which we have termed trabeate. The principle of arcuation has never been so thoroughly and magnificently developed as in the fan-vaulting peculiar to Perpendicular architecture.

It has been objected to the panel-work of this style that it produces "an easy but gaudy system of surface decoration." The objectors seem to forget that each style is capable of being treated skilfully and unskilfully, and that, after all, its excellence depends principally on the competency of each individual architect. It cannot be denied that throughout the Perpendicular period the facility of producing embellishment by panel-work was frequently abused—just as in the Decorated period flowing tracery frequently became entangled and confused. The Mediæval architects with all their skill were not infallible (*bonus dormitat Homerus*). What then?—because the use of panelling was sometimes excessive was it always so? Was the whole character of Perpendicular an easy but gaudy system of surface decoration? Look at the external architecture of King's College Chapel. Not much surface decoration there! Plain almost to severity—bold almost to ruggedness, this glorious pile exhibits more *massiveness* than any other Mediæval monument whatever. In the colossal disposition of its parts, it outvies even Norman architecture; as for Decorated buildings, there is not one of them that exhibits the same play of light and shadow. It seems almost incredible that those who have constant opportunities of seeing this Chapel should speak of Perpendicular architecture as characterised by superficial decorations.

If art is to progress, its resources must be increased—not diminished. Yet, how much must we relinquish if we decide on abandoning Perpendicular architecture? Fan-groining, the most magnificent of all methods of roofing; the four-centred arch which, not to speak of its constructive value, exhibits in its outline when correctly worked a peculiar grace which no other arch possesses; the curves of contrary flexure in Perpendicular canopies; the square headed Tudor arches with their exquisite spandrels; these are part only of the wealth which we lose by the rejection of Perpendicular architecture. In no other style were the windows entirely incorporated with the rest of the building. In Early English they were frequently nothing but mere perforations; in Decorated they appear more connected with the rest of the architecture, but it was not until the Perpendicular period that the problem of identifying them with it was truly solved. There are many Decorated churches in which some of the windows might be blocked up without any perceptible alteration in the character of the architecture; but it would be absurd to make the same experiment in a Perpendicular edifice. Unity and harmony are essential elements of beauty, and the most perfect architecture is surely that in which each member is an integral and essential portion of the whole system.

The most effective way of advancing Pointed architecture seems to be the liberal adoption of all three styles, and the careful preservation of the distinctive characters of each. They who object to this course would have us give up all the peculiar beauties of the third style, and would recommend Decorated architecture, or rather a transition between it and Early English, as the model for invariable adoption. A new church of the pure Lancet architecture, or Romanesque, or Perpendicular, *ipso facto*, meets with their condemnation. They affect a zeal for the future progress of Pointed architecture, and yet would confine it within the narrowest compass. They would fill the land with buildings of which the variety and originality should be a minimum;

Facies non omnibus una,
Nec diversa tamen.

Such edifices would bear the same relation to the glorious works of our ancestors which prize poems do to poetry. They would bear all the academical polish and insipidity of the former, without a particle of the genius and spirit of the latter.

It remains with architects to judge for themselves which path they will choose—whether they will limit themselves to one style, or adopt the catholic feeling which we have here advocated. We have, however, one parting word of advice to those who presume to build in styles proscribed by either of the Universities. These architects are almost certain to be condemned by one or the other class of academical critics, and if the criticisms be founded merely upon the distinctive prejudices of either body, may safely congratulate themselves that no more serious objections have been alleged against them.

We are sorry to have to inculcate a certain amount of indifference to criticism, but it is necessary for the purpose of our present paper—a more liberal and extended view of Pointed architecture—that we should do so. At the same time, the architect must be warned that if his efforts be condemned on purely architectural grounds, the condemnation usually proceeds from those who are qualified to pronounce it. We have no reluctance in saying that we have learned much from the pages of the *Ecclesiologist* and the Reports of the Oxford Architecture Society. With respect to our contemporary especially, we have seen with great satisfaction the tendency recently exhibited to advocate progress in architecture: instead of being told that antiquity and perfection are synonomous, we are now bidden to look forward to a perfection of English architecture, compared with which the glories of Cologne shall be as nothing. There are many other points of sympathy between us—the war against unfaithful architecture, which, however, we do not limit to the Mediæval styles—the condemnation of superficial "save-trouble" expedients—the admiration of such men as Didron, Willis, and—let us add—the author of the Manual of Gothic Mouldings. We recognise the general soundness af the architectonic criticisms of the *Ecclesiologist*, and if ever we dissent from them it is with regret; but we have uniformly found the most liberal and general views of art to be the most valuable, and are unwilling to sacrifice its interests to an exclusive spirit which, we believe, will be found on examination to result from the prejudices of academical education.

Our paper has already reached considerable length, and this must be the excuse for not fully examining the proposed alterations in the nomenclature of Pointed architecture. Brevity on this subject is the less to be regretted, because names are less important than things. A good nomenclature is that which is definite, generally received, and not liable to be changed. For this reason we are unwilling to disturb the well known appellations invented by Rickman for the three great divisions of Pointed architecture—Early English—Decorated—Perpendicular. These names have certainly the fault of want of homogeneity: the first refers to a date, the second to the amount of ornament, the third to the character of the ornament. The dissimilarity between the second and third is however avoided by remembering that Rickman spoke of Decorated in contradistinction to Florid, one of his names for the third style. These names however are well understood, and being suggestive are easily remembered. The titles First, Second, and Third Pointed, are not so suggestive, and besides are unnecessary innovations. They are also deficient in homogeneity. For the term Pointed should be balanced against the term Round, as the Ecclesiologist tacitly confesses, in the same way as the French term Ogival is balanced against Plein Ceintre. Yet the advocates of the new names inconsistently call the style anterior to Pointed—"Romanesque," from the name of the People from whom this style was mediately derived. The term Third Pointed has also the grand defect of confounding Perpendicular with a style altogether different—Flamboyant. The old nomenclature is not theoretically perfect, still it is more so than the new one, and besides is sufficient for all practical purposes.

We agree with the *Ecclesiologist* in condemning the term Gothic. Historically speaking, it involves an anachronism, and, moreover, it was invented as a term of reproach by those who knew nothing about it. For the latter reason we also object to calling Classic architecture Pagan—we would as soon speak of classic literature as Pagan. The term confounds a style which the *Ecclesiologist* confesses to be "faithful," "beautiful," and to have been produced by a "beauty-loving people," with the architecture of the Hindoos and Mexicans. There can be no objection, however, to the application of the term to the mongrel architecture of "Classic" cathedrals, and to all attempts at combining the horizontal construction of the Grecian with the vertical construction of the Mediæval architects.*

ARCHITECTURAL RECOLLECTIONS OF ITALY.

By Frederick Lush.

(*Continued from page* 169).

In considering any ornaments in connection with the architecture of Italy, or the numerous bronze and marble works which adorn her piazzas, we see how much the grander and more imposing character of buildings is set off by these smaller embellishments. In Tuscany, and elsewhere, in the time of Lorenzo Ghiberti and Donatello, the churches and cathedrals were decorated with apostles and scriptural subjects, and heroes occupied her colonnades; in the same way as formerly fables were represented by Phidias on the temples, and statues of gods and sages stood under the porticoes of Greece. And the similar works were attended with corresponding happy results. In each epoch and country, the artist "felt himself a public benefactor;"† and he was one. Now, in Italy, the respect paid by the lowest and most uneducated classes to artists, whether native or foreign, is greater, perhaps, than it is in any other country; and we think this is chiefly owing to the exhibition of works of art in all her public places. However easy of access they may be, museums and picture-galleries will do little towards enlightening the people and interesting them in the cause of the fine arts, compared with the good derived from the works of acknowledged artists, in spots which men habitually frequent. Nothing has had such a tendency in the south to engage the feelings and

* We must guard ourselves against appearing to condemn the use of heraldic devices where occasion renders them necessary. The condemnation in the text refers to the gratuitous employment of monstrous and unnatural forms as purely architectural ornaments.

† Hazlitt.

induce the mind to reflect and grow refined, or instil into it patriotic ideas, as the presence of such productions in the squares and in the streets. The public taste is thereby constantly exercised. Indeed, so many are the portions of ground appropriated exclusively to works of genius, that it may be said the taste of the people could not degenerate, even were the treasures of the Vatican or Uffizii unknown to them. The effects, also, of viewing these works in the open air are more healthful, and, on account of the freedom and independence of the spectator, yield a pleasure superior to that afforded by works of the same description within a palace; the glorious sun that heightens these beautiful objects rendering the Italians at the same time susceptible of every emotion which it is in the power of art to inspire. Every traveller must have heard the exclamations of praise that are uttered by mule-drivers, beggars, porters, and boatmen, when looking on the colossal figures which adorn some fountain, or a noble group of statuary in one of their favorite squares. And all admire these places abroad, from prince to peasant. It was gratifying to me, when in Venice, to see the blind Holmein feeling and passing his hands over the beautiful bronze and marble works in that city, and to witness the lively pleasure he experienced from such monuments. The impressions thus produced only make us regret that art does not develope itself to the same extent in England, and that such things are not carried out on that magnificent and liberal scale we see in the Italian cities. An opportunity which was lately offered for making one of the most splendid piazzas in the world, in front of the National Gallery, was thrown away; and, with the exception of the equestrian statue to King Charles, the whole is now a disgrace to the nation, and one mass of rubbish. This is the more to be regretted, because the artists of our time take precedence of the moderns in Italy; and were there less *false* and more *real* patronage, some of our first sculptors would have graced the spot with subjects rivalling the best productions of ancient Greece.

To those men who contributed so much to the restoration of art in Italy, we owe the most beautiful works in her great squares; and we cannot forget that the sculptors of those grand works in the Piazza del Granduca, at Florence, of the bronze gates to the Baptistery in the same city, of the fountains in Rome, Perugia, and Bologna, whilst they attained excellence in that high style of art which they exhibit, were at the same time, or had been, jewellers, *mosaicisti*, and medallists; and that the practice of putting together the minute fragments of stone or glass, or cutting the shell or cornelian into admired cameos, did not prevent them from executing some of the grandest works ever known in sculpture; works, of which the reputation is sealed by the enconiums of Michael Angelo and of our own Flaxman.

II.

"Few of these palaces are of good architecture—some of very bad; others are whimsical, but present among their strange forms many happy ideas."—Wood's "Letters of an Architect," &c.

The details of the Venetian palaces are valuable, because they lead the mind, like all eccentric but beautiful things, to think and invent for itself. Their peculiarities and caprices of style are positive faults if tested by the standard of the Classic examples, or by Palladio; yet, for all this, we see in the composition of the windows, balconies, and other parts of the palaces of Venice, principles of real beauty. An early and too exclusive admiration of the Roman edifices is apt to prejudice the mind against them; but we think they must be studied by all who would not separate the painter from the architect.

The architecture of Venice is what the city itself is in its history and associations—strange and romantic; and her Doge's palace, fairy-like and Eastern in its appearance, reverses the principles of all other architecture. As Forsyth* says,—"Here the solid rests on the open, a wall of enormous mass rests on a slender fretwork of shafts, arches, and intersected circles. The very corners are cut to admit a thin spiral column, a barbarism which I saw imitated in several old palaces. A front thus bisected into thick and thin, such contrast of flat and fretted, can please only in perspective. It is not enough that the structure be really durable, it should also appear so." The writer had, however, formed his notions of architectural beauty and propriety on the precepts of Vitruvius and Palladio, and anything contrary to these was immediately ridiculed and censured by him. Now, the sketch of the Doge's palace (fig. 1) shows, with all its defects, what a pleasing beauty it has about it; an effect which it owes solely to its departure from those prescribed rules. On the other hand, we see edifices which the judgment might pronounce faultless, most correct in the proportions usually given to them, most perfect in the features suitable to their particular class, and, indeed, without any of those vagaries which are here displayed—before which the mind remains cold and unexcited. A total incapacity of raising pleasurable emotion must beget apathy, if not

Fig. 1.

disgust, towards an object. A building, like a book or a picture, may be without a single absurdity, yet be very far from beautiful. Now, in the works of those men who thought for themselves, and were more ambitious to be artists than imitators, we often find that, in departing from conventional rules, the defects (if such they were) were redeemed by the invention of some striking beauties which pleased the imagination, exercised, whilst it fascinated the eye, and at least possessed the merit of originality and that charm which all works of great invention have—of which dull copies are always destitute. Instances of these abound in Venice, and in many of the Italian cities, exhibiting an approximation to the Gothic in feeling, although that result was attained in quite a different way; in the Loggia of Sansovino, for example, and that of Lanzi, and in the cornices and other parts of these celebrated designs, on which has been bestowed great attention; in San Michele, Florence, also, remarkable for the beauty of its crowning member and the tracery of its windows: and in the Palazzo Publico at Placenza and Como.* It should only be remembered that whilst on one side, by too strictly following precedent, we often substitute elegance for sentiment; on the other, a too open defiance of it, might lead to a corruption of true taste.

It is observable in the Ducal palace, as in many other Venetian buildings, how well the contrast between the flat mass of wall and its windows is effected; how admirably one part serves to relieve the other; also how the coloured diamond patterns on those masses reduce the heaviness which might otherwise appear too great for the light, ornamental corridor below.

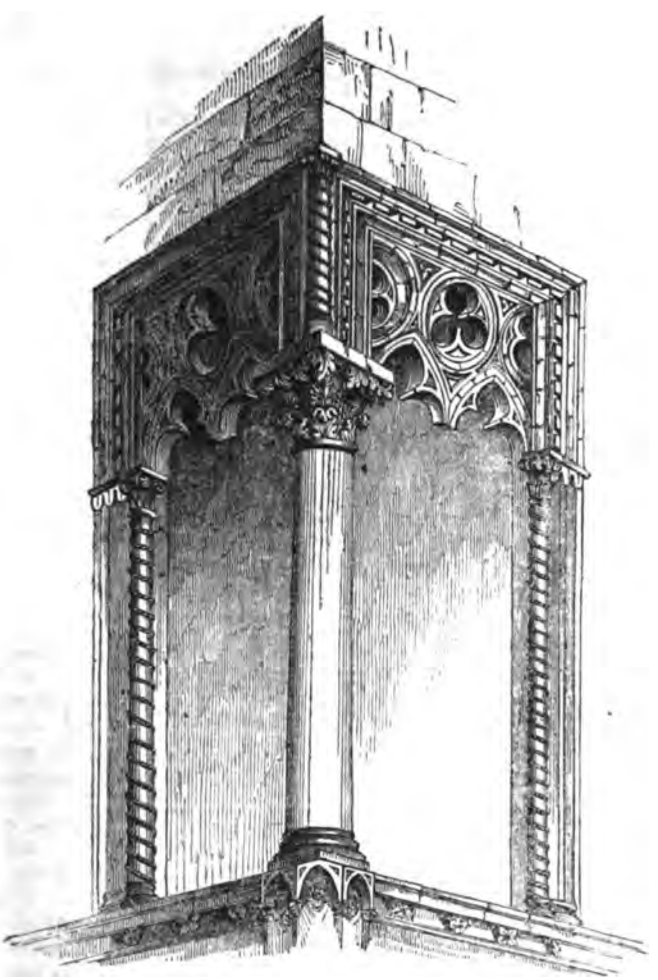
The angular balcony and recess (fig. 2) from another palace is a "barbarism" perhaps not likely to be committed by many English architects. Nevertheless it is very beautiful. It was ingeniously contrived for commanding, from one point, different views on the canals; but for this and a thousand other similar picturesque features in her buildings, with the memories they awaken of her former pageantries, Venice would lose more than half its enchantment. Such things fully express their meaning in this wonderful city, and impress the mind with all that poetry and romance that is infused over it. They must be applied, however, with great caution to other places and circumstances, for, bearing, as they do, more the stamp of power and the force of original thought, than the evidence of good taste, they should serve rather as stimuli to invention than as examples for imitation. The danger of sacrificing correct drawing and just representation to a love of splendour, of which Reynolds, Fuseli, and others, warned the student in the fascinating colours and wild compositions of the great Venetian painters, might equally be incurred in an immoderate fondness for the florid palaces of Venice and the fanciful creations of the Moor.

* "Antiquities, Arts, and Letters in Italy."

* See "Illustrations to Hope's Historical Essay on Architecture," and Cicognara—Fabbriche piu cospicue di Venezia.

It is easy to recognise a correspondence in the principles and effects both in the painting and architecture of Venice.

Fig. 2.



That variety of tints, of forms, of colours, and of the manner of breaking and blending them into one another, which is seen, with one or two exceptions, in the Venetian painters, was in itself extremely attractive; but its merit of beauty and picturesqueness was fatal to all grandeur and dignity. So in the architecture, there were such a richness, such an intricacy, so many curves of contrary flexure (archi proteiformi), and, as it would sometimes seem, such a positive avoidance of anything like uniformity or a long continuation of lines, that, picturesque though it be, and interesting for reasons already given, it was yet far removed from simplicity and grandeur of effect. All these highly ornamental qualities were rejected by the Roman and Florentine schools, which excelled in the grand and imposing style; and those palaces of Rome and Florence, which have the national features most strongly marked on them, as the Farnese, Strozzi, and Pitti, contrasted with those in Venice most remarkable for *their* peculiarities, present the opposite characteristics of grandeur and mere picturesque beauty as much as objects totally differing from each other possibly can do.

III.

Although the marked characteristics of these styles arose out of peculiar times and circumstances; yet it must be allowed that the details of these edifices are attributable partly to the amount of the labour bestowed on them and, in a great measure, to the degree of artistic skill and knowledge of pictorial effect possessed by the Italians. At a period happy for art they united the painter with the architect. Dominichino, Raphael, Michael Angelo, were the better able (as were also our Christopher Wren and Vanbrugh) to impress some originality and power on their works, from possessing this combination of talent. Ornaments, showing great attention to *chiar' oscuro*, and a knowledge of the artificies of contrasting light with shade and producing relief, and executed with reference to the distance at which they would be viewed, are well displayed in some of the details of buildings in Italy, as well Roman as Italian-Gothic; although is a different, rather than, perhaps, to a less extent than that seen in the elaborate enrichments of Gothic architecture.

Thus in many of the Italian cornices,* as in the brick and terra-cotta ones in Padua and Ferrara, but especially (as being likewise of superior material) in that to the Strozzi palace, there is such a union of boldness and richness—and sometimes these qualities stand out so conspicuously singly, that they make all the impression on the spectator which it is possible for such things to do; deriving their effects from bold projection, breadth of shade, and judicious arrangement of surfaces; and not these members only, but the chimneys, which make such sorry figures on our roofs, are remarkable for their beauty and the outline they offer against the sky; and the deep effective border ornaments and decoration to doors and windows often receive all the character and importance of which they are susceptible.

Let any one compare this Strozzi cornice with any cornices in England, designed on buildings of an equal size with that palazzo, and he will see and lament the difference. The former has been accused of "projecting beyond all authority"—by so doing it becomes a bold and spirited production. In England, too often this feature, even in large public buildings, where it is capable of being made imposing, and ought to be so, dwindles into insignificance and meanness; for their parts are seldom large and definite enough; but often too small and too confused; no account is taken of the point of view whence they are beheld; and little attention is given to increase as much as possible the effect of light and shade, by making some parts prominent and deepening the recesses of others, as, for instance, in the dentiles, and egg and tongue moulding. From neglecting this, those portions of the cornice are often entirely lost in the open air to the eye, and require, in order to be seen at all, to be brought within the bounds of the architect's own room, or else to be viewed through a telescope.

* "When they came to the cornices—the massive unbroken cornices of their palaces—the littleness of the other parts is so completely lost, that it is evident they were actuated by the same feelings of unity and breadth that lent so much value to the best works of the ancients. . ... I cannot refrain from calling the attention of the student to the cornices employed by the Florentine school, inasmuch as there is no member of a building from which it receives so great an assistance and effect as from the cornice. In the best and most celebrated examples, such as the Strozzi and Pandolfini palaces, and the Picolomini palace at Sienna, whose court and staircase are of extraordinary beauty, the cornice is proportioned to the whole height of the building, as the height of an order, notwithstanding the horizontal subdivisions and small cornices that occur between the ground and the crowning members. Not less celebrated than those just mentioned, is that of the Farnese palace at Rome, which has always been considered one of the most powerful architectural efforts of Michael Angelo."—Gwilt's "Elements of Architectural Criticism."

A NEW THEORY OF THE STRENGTH AND STRESS OF MATERIALS.

By Oliver Byrne, Professor of Mathematics.

(*Continued from page 167.*)

The work done in elongating a bar to its elastic limit, whose sectional area is one square inch, and length one foot, equal to $\frac{1}{2} M_e \left(\frac{l}{L}\right)^2$, supposing the limit to be expressed by the fraction $\frac{l}{L}$; in this case $A L = 1$

The units of work done in elongating any other bar of the same material as the last, whose length equal L, and sectional area equal A, to its elastic limit, $= \frac{1}{2} M_e \left(\frac{l}{L}\right)^2 A L$. It is evident that $\frac{l}{L}$ is the same value as in the last case, hence, $\frac{1}{2} M_e \left(\frac{l}{L}\right)^2$ is the same in all cases with bars of the elongated to their elastic limit. $\frac{1}{2} M_e \left(\frac{l}{L}\right)^2$ is called the modulus of Resistance, and may be written M_r, and is sometimes called the modulus of longitudinal Resilience. If the work of elongating goes on till fracture is produced M_f, the work necessary to cause fracture in a bar a foot long and an inch square, is styled the modulus of fragility, so that $M_f L A$, will express the units of work that will cause fracture, in the same manner that $M_r L A$ expresses the units of work to extend a bar to its elastic limit. By-and-by we shall explain what is understood by the term Modulus of Rupture in Transverse Strains. The modulus of fragility, M_f, must not be mistaken for the unit of tenacity, which is the number of pounds that would tear asunder a bar one square inch in section. Length is not taken into account in the unit of tenacity, but as the strain is supposed to be on the highest section of the bar, it is therefore at this section the rupture will take place, hence the length must be taken into account in determining the weight that produces fracture.

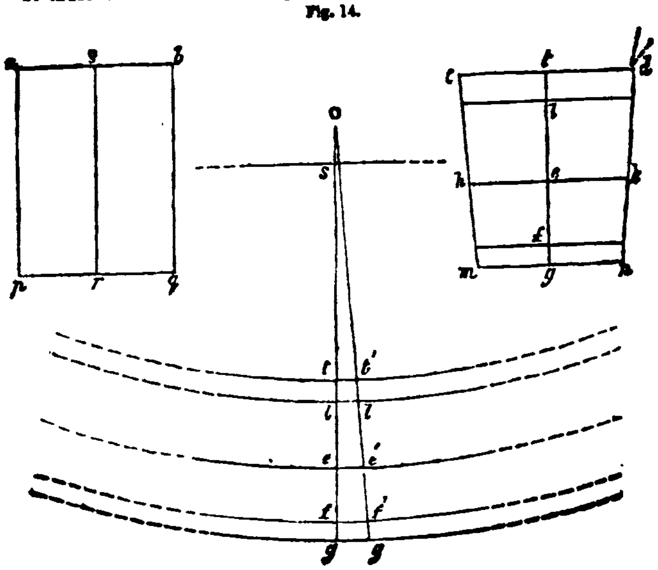
Condition of rupture in a rectangular beam under a transverse strain.

Let us next consider the nature of the forces exerted by the filaments of the cross section, near g, when the beam is in the state bordering upon rupture.

Let g' be any point of the curve $g\,g'$, very near g; and let the normals $t\,e\,g$ and $t'\,e'\,g'$ meet in the point o. Let ρ = the radius of curvature of the mean filament, $e\,e'$, at the point e, that is, the filament which is in a middle state between $t\,t'$ and $g\,g'$; it is represented by $h\,k$ in the cross section through $t\,g$; $h\,k$ is in such a position that it is equal in length to $a\,b$ or $p\,q$, the breadth of the beam before the weight W was applied.

It must be observed that fig. 14 is part of fig. 13 enlarged, the same

Fig. 14.



letters represent the same parts, and that $e\,e'$ is not considered neutral. Let $\sigma = e\,e'$; x = the distance of any filament whatever as ff', from the mean filament, and σ' the length of ff'

$of' = \rho + x$ = radius of curvature of ff', at the point f, then,

$$\sigma : \sigma' :: \rho : \rho + x$$

$$\therefore \sigma' \rho = \sigma \rho + x \sigma, \quad \sigma' = \sigma + \frac{x\sigma}{\rho}.$$

On account of the forces applied, the longitudinal filaments undergo small dilations, which will destroy the equality that existed between σ and σ' before the forces were applied. Let a = the primitive magnitude, then, supposing δ and δ' very small fractional parts of a, so that

$$\sigma = a(1+\delta) \text{ and } \sigma' = a(1+\delta')$$

$$\therefore a(1+\delta') = a(1+\delta) + x\,\frac{a(1+\delta)}{\rho}$$

$$\therefore \delta' = \delta + \frac{x(1+\delta)}{\rho} = \delta + \frac{x}{\rho} + \frac{x\delta}{\rho}.$$

Let $t\,t' = a(1-\epsilon')$; $g\,g' = a(1+\epsilon)$; $l\,l' = a(1-\delta'')$; and let the height of the fibre at $g = i$, and breadth $a\,b$ or $p\,q = \beta$, that is, the breadth before the force is applied. $e\,f = x$; $e\,l = y$; $e\,g = a_1$; and $e\,t = a_2$. When the element or fibre at g, becomes expanded till its length a becomes $a(1+\epsilon)$, then its breadth will be $\frac{\beta}{(1+\epsilon)^{\frac{1}{2}}}$, and height $\frac{i}{(1+\epsilon)^{\frac{1}{2}}}$, the height i is so small, this supposes the cross section of the extreme fibre, before the expansion takes place, to be similar to it after being expanded,*—mind we say similar, not equal, for $\frac{\beta}{(1+\epsilon)^{\frac{1}{2}}}$ is less than β; so the breadth is diminished. It will be perceived that we are here speaking of the lower filaments at g.

* The assumption seems inconsistent with the assumed flattening of the beam. For it is clear that if the proportion between the depth and width of the constituent elements remains unaltered, the proportion between the depth and width of the whole beam must be unaltered. If the upper surface of the beam bulged out, the depth of the upper filaments would be diminished and the width increased—if we assume the density to remain constant. But this assumption also is contrary to our knowledge of elastic bodies and to Hooke's Law.—Ed.

$$a_1 : (a_1 - x) :: \beta - \frac{\beta}{(1+\epsilon)^{\frac{1}{2}}} : \frac{a_1 - x}{a_1}\left(\beta - \frac{\beta}{(1+\epsilon)^{\frac{1}{2}}}\right)$$

$\therefore$ the breadth of the fibres at $ff' = \frac{\beta}{(1+\epsilon)^{\frac{1}{2}}} + \frac{a_1 - x}{a_1}\left(\beta - \frac{\beta}{(1+\epsilon)^{\frac{1}{2}}}\right)$ $= \frac{\beta}{a_1}\left\{a_1 - \left(1 - \frac{1}{(1+\epsilon)^{\frac{1}{2}}}\right)x\right\}$. The force arising from the action of ff' is proportional to δ', and may be represented by $m\,\delta'$, m being a constant depending upon the nature of the material of which the bar consists; therefore, the normal force which corresponds to the point f, normal to $t\,g$, is represented by $\frac{\beta}{a_1}\left\{a_1 - \left(1 - \frac{1}{(1+\epsilon)^{\frac{1}{2}}}\right)x\right\} m\,\delta'\,dx$, and the moment of all the forces normal to $e\,g$ with respect to the axis $h\,k$ = M =

$$\frac{m\beta}{a_1}\int_0^{a_1}\left\{a_1 - \left(1 - \frac{1}{(1+\epsilon)^{\frac{1}{2}}}\right)x\right\}\delta'\,x\,dx$$

but $\delta' = \delta + \frac{(1+\delta)x}{\rho}$; hence, by substitution,

$$\mathrm{M} = \frac{m\beta}{a_1}\int_0^{a_1}\left\{a_1 - \left(1 - \frac{1}{(1+\epsilon)^{\frac{1}{2}}}\right)x\right\}x\left(\delta + \frac{(1+\delta)x}{\rho}\right)dx$$

Therefore M equal

$$\frac{m\beta}{12\rho}\left\{\left[6 - 4\left(1 - \frac{1}{(1+\epsilon)^{\frac{1}{2}}}\right)\right]\delta\rho a_1^2 + \left[4 - 3\left(1 - \frac{1}{(1+\epsilon)^{\frac{1}{2}}}\right)\right](1+\delta)a^3\right.$$
$$\left.(1+\delta)a_1^3\right\}; \text{ but } \rho : \rho + a_1 :: a(1+\delta) : a(1+\epsilon);$$

$$\therefore 1 + \delta = \frac{\rho(1+\epsilon)}{\rho + a_1} \text{ and } \delta = \frac{\rho\epsilon - a_1}{\rho + a_1}$$

$$\therefore \mathrm{M} = \frac{m\beta a_1^2 \rho}{12(\rho + a_1)(1+\epsilon)^{\frac{1}{2}}} \times$$

$$\left\{\left(2(1+\epsilon)^{\frac{1}{2}} + 4\right)(\rho\epsilon a_1) + \left((1+\epsilon)^{\frac{1}{2}} + 3\right)(1+\epsilon)a_1\right\}$$

This being established, we shall next determine the nature of the forces between e and t, or on the area $h\,k\,d\,c$. The breadth of the extreme fibres at $t\,t' = \frac{\beta}{(1-\epsilon)^{\frac{1}{2}}}$; $o\,t = \rho - a_2$; $o\,l = \rho - y$.

$$a_2 : y :: \frac{\beta}{(1-\epsilon_1)^{\frac{1}{2}}} - \beta : \frac{y}{a_2}\left(\frac{1}{(1-\epsilon_1)^{\frac{1}{2}}} - 1\right)\beta$$

$\therefore \frac{y}{a_2}\left(\frac{1}{(1-\epsilon_1)^{\frac{1}{2}}} - 1\right)\beta + \beta = \frac{\beta}{a_2}\left\{a_2 + \left(\frac{1}{(1-\epsilon_1)^{\frac{1}{2}}} - 1\right)y\right\}$ = the breadth of the fibres at $l\,l'$. The elastic forces of compression between e and t, as well as those of extension between e and g, tend to turn the surface of rupture in the same direction about the axis of rupture. The moment of all the forces normal to $e\,t$, with respect to the axis $h\,k$, which we shall call M_1, is equal

$$\frac{m_1\beta}{a_2}\int_{-a_2}^{0}\left\{a_2 + \left(\frac{1}{(1-\epsilon_1)^{\frac{1}{2}}} - 1\right)y\right\}\delta''\,y\,dy;$$

$$\text{but } \delta'' = \frac{\epsilon_1\rho - a_2 + (1-\epsilon_1)y}{\rho - a_2},$$

$$\text{for } \rho - a_2 : \rho - y :: a(1-\epsilon_1) : a(1-\delta'').$$

$$\therefore \mathrm{M}_1 = \frac{a_2(\rho - a_2)}{m_1\beta} \times$$

$$\int_{-a_2}^{0}\left\{a_2 + \left(\frac{1}{(1-\epsilon_1)^{\frac{1}{2}}} - 1\right)y\right\}\left\{(\epsilon_1\rho - a_2) + (1-\epsilon_1)y\right\}y\,dy.$$

$$\therefore \mathrm{M}_1 = \frac{m_1\beta a_2^3}{12(\rho - a_2)(1-\epsilon_1)^{\frac{1}{2}}} \times$$

$$\left\{\left(-10(1-\epsilon_1)^{\frac{1}{2}} + 4\right)(\epsilon_1\rho - a_2) + \left(-3 + 7(1-\epsilon_1)^{\frac{1}{2}}\right)(1-\epsilon_1)a_2\right\}$$

Now the elastic forces M and M_1, when the beam is on the point of breaking, together with the pressure applied at B or A (fig. 7), which is equal to half the weight W and half the weight of the beam.

Representing, therefore, by w the weight of the beam,

$$\mathrm{M} + \mathrm{M}_1 = \tfrac{1}{2}(\mathrm{W} + w) \times r\,\mathrm{B}$$

Let $r\,\mathrm{B} = p$ = half the distance between the supports = the perpendicular let fall from the axis round which the section of rupture turns upon the direction of the pressure at A or B. In the next number will be pointed out the erroneous principle upon which Hooke's law is founded.

(To be continued.)

CANDIDUS'S NOTE-BOOK.
FASCICULUS LXIX.

"I must have liberty
Withal, as large a charter as the winds,
To blow on whom I please."

I. Even should Burton's arch prove able to bear Wyatt's Wellington comfortably, it is more than in all present likelihood good taste will be able to do. If those who are mainly concerned and interested in hoisting up the statue to that "bad eminence" and unenviable point of exaltation for it, have felt all along so assured of a satisfactory result, how happens it that they have not imparted some degree of that same comfortable assurance to the public, if only to stop the mouth of criticism? Some half dozen years ago, indeed, a mere flat pasteboard sort of scheme of the figure was stuck up on the top of the arch for a day or two,—and a strange figure it cut, which may have been one reason for taking it down again as expeditiously as possible, instead of allowing time for its being generally seen. In the interim, which has been a tolerably long one, nothing farther has been done in the way of precautionary trial, or if it has been done, the public have not been informed of it. Yet most assuredly it would not have been amiss, had a good-sized model of the structure with the equestrian figure upon it, been prepared, and exhibited at the Royal Academy; besides which there should have been perspective views also taken from different points, in order the better to determine what would be the effect of such contemplated "improvement" of the arch, upon the other buildings and objects in its immediate vicinity. Hardly could the expense attending such model and drawings have been made any objection or difficulty, where so goodly and serious a sum as Thirty-thousand pounds or thereabouts was to be expended, and that upon a single work of art. It is well should the managers not prove to have been penny-wise and pound-foolish in the matter, and should the work so liberally subscribed for, not verify the proverb of buying a pig in a poke. The thirty thousand pounds for the bran-new statue by our modern Phidias, is not much less than what the priceless Elgin Marbles cost the country; or than what would have secured to us the entire Houghton collection, and prevented its going out of the country. Alas! for those days! Among the whole monied aristocracy, among all our wealthy collectors, nay among our city millionaires, there was not one who cared to glorify his own name by inseparably uniting it with that of the Houghton Collection. Many could easily have snatched the prize from the grasp of the Russian Catherine, by merely taking up a pen, and giving a cheque for the sum demanded—a sum that has frequently been staked at the gaming table without compunction or hesitation.

II. By way of apology for, or in order the better to reconcile us to the Wyatt Wellington—which might adorn some other situation, being put where it will prove a Wellington "out of place," we are told that the idea has been sanctioned by the consent of the late and present Sovereign. Now as to William IV. it is notorious that he neither had nor pretended to have any taste at all for art—and that last was some merit; he neither knew nor cared about it; and as to the consent of her present Majesty, it may fairly be suspected that it is merely a negative one. Like Dickens' Mrs. Davis—if such very uncourtly comparison be allowable—she does not care to be "worritted" about the matter,—though of course there is no such word as "*worrit*" in the vocabulary of royalty,—so leaves the managers and subscribers to please themselves in the affair.—Granting that the Arch may be able to bear the enormous weight that will be put upon, secure enough for some time to come, yet the time will come, sooner perhaps than is thought of, when the structure will require repair, and when it be so loaded, will not that be an operation attended with some hazard, as well as very great difficulty? It will not be matter for much surprize should it eventually be found necessary to fortify the work by converting the hollow parts within the structure into solid masses of earth, concrete, and brickwork. At all events should the scheme be persisted in, we shall have a huge Wellington mounted on guard before little Apsley House, which for an *Arch*-duke's mansion is as lilliputian in taste as it is in dimensions. Instead of giving us a mere "sentinel" statue, might not the artist have properly thrown a little allegory into his work,—have represented the hero of Waterloo not exactly fast asleep, but merely taking a nap, while perfectly wide awake?—or rather, putting that said Nap to flight.

III. Speaking of the decoration of rooms and of his conversations with the late Stuttgart architect, Thouret (who died January 17, 1845) on the subject, Goethe says that the *imitation* of granite, porphyry, and all sorts of marbles, &c., is matter of great importance (*sehr wichtig*). Consequently he for one—and his opinion may be allowed to stand for something, even should it not entirely remove the scruples of the ultra-conscientious,—did not look upon such imitation as mere "sham," unworthy the dignity of genuine architecture. The deception is surely of perfectly legitimate as well as innocent kind, for we all know that in the most sumptuous palaces or other buildings the internal walls never are or can be of solid marble, at the utmost are only incrusted with such material. So long as the construction of a building be sound, and calculated for durability, what matters it though the beauty which array it, and captivates the eye, be only skin-deep? Fresco paintings themselves are only superficial; the external surface once gone, no redressing or repolishing can revive it. It is no argument against the imitation of costly and perhaps somewhat inapplicable materials also, that it is apt to be very paltry. It certainly is not necessarily so, for it may, on the contrary, be very excellent; and as the processes by which it is produced partake more of mere manipulation than art, excellence—positive merit can safely be ensured for it beforehand, which is assuredly no small advantage. Those who affect to despise all deception of the kind, may be left to reconcile to themselves as well as they can, that of gilding, by means of which the most valuable of all metals is counterfeited for purposes to which that or any other metal would be perfectly inapplicable,—picture frames, for instance, which though apparently of gold are, and are known to be, only of ordinary wood gilded over.

IV. Barry is now not only eclipsing Soane, but absolutely extinguishing him bit by bit, at least in the purlieus of Westminster. Poor Soane! not only has the exterior of his "Board of Trade" been so completely refashioned, as to be metamorphosed into a different piece of architecture, but his Scala Regia and Gallery, and his Law Courts—on which last he prided himself so especially, are doomed to pass away, without leaving a wreck behind, or other memorial of them than the wretchedly vile engravings of them in his "Public and Private Buildings," a work remarkable for nothing so much as the extraordinary penuriousness with which it was got up, more particularly the old architect's character for "munificence" considered. Poor Soane! pity that he had not the heart to be a little more liberal towards himself,—somewhat less positively stingy. Poor Soane! too, it will be doubly, if Britton should now pass by him without mention, when recording the other distinguished patrons and persons of talent whom it has been his good fortune to attract to himself during his long and industrious career. Will he now cut "his esteemed friend Sir John Soane," or will he recant,—at least qualify his former admiration by giving a dark *à la* Rembrandt portrait of him?—*Nous verrons.*

V. Welby Pugin has obtained a distinction very rarely conferred in any shape, upon members of the architectural profession, however eminent they may be, namely, that of having an engraved portrait of him published. To say the truth, architects are treated as a sort of *Impersonals* by the public,—creatures without bodies, therefore it is to be presumed, all intellect, all mind. At any rate, it seems to be taken for granted that no one cares to behold what manner of men they are in outward shape and physiognomy. You shall look over catalogues and lists of portraits, and among thousands will scarcely find one of a single architect. It fares very little better with foreign architects than with English ones: portraits of recent or living ones are rare phenomena. Things of the kind may be painted, but they are not transferred to copper or stone, *pro bono publico.* There is a published portrait of Cagnola, one—nay two, if not more, of Schinkel; beyond which number the list can hardly be extended. It may be questioned if there be one even of Zwirner, although a likeness of him ought to be in request with the multitude, he being the architect employed upon the works at Cologne Cathedral. What Nagler will say of Zwirner is not likely to be known—at the rate his work progresses—till some twenty years hence. When he does reach him, it is to be hoped that he will not blunder so egregiously, as he did about Pugin—or rather the two Pugins, father and son, of whom he completely made mincemeat, by chopping them both up together, and stuffing the compound into one article.

VI. The second series of Allom's "France Illustrated," is decidedly inferior to the first, as regards interest of subjects. In that respect it exhibits a deplorable falling-off; and hardly less than deplorable it is to find him, after giving us such delicious interiors of the Madelaine, the Pantheon, and several of the apartments at Fontainebleau—that excepted, called the Salon d'Abdication, a very commonplace room, remarkable for nothing more than a very big-headed Napoleon in an arm-chair,—he should dish up for the second course, such watergruel things as monotonous landscapes—chiefly all mountains and skies, that we seem to have met with before, again and again, there being nothing in scenery of the kind to individualize and extinguish one particular spot from another, wherefore one or two specimens are as good as a score or two,—nay, very much better, because there is then more room for better subjects. And pray, has Mr. Allom taken leave of Paris?—does he not intend to let us have from his truant pencil—views (interior and exterior) of Notre Dame de Lorette, and St. Vincent de Paule, of the Ecole des Beauh Arts, the Hotel du Quai Orsay, the Hotel of the Banker Hope, and many other edifices which would show his forte? Let him labour in his own proper vocation and he will be almost unrivalled in that department of architectural illustration in which he has evidenced such captivating talent in his "Constantinople," and his "France." As much cannot be said for the putter-together of the letter-press in the latter work, for of architecture he seems to know actually nothing,—is altogether unable to speak of buildings, except by sometimes blundering most *deliciously*, as when he talks of the Theatre at Bordeaux been adorned with "interesting"! Corinthian pilasters, which is nearly all that he says of it!

VII. Schlegel was not very wide of the mark in saying "Art has become a slop-shop for pedantic antiquities." Those who pretend most to busy themselves and to take interest in it, give their attention chiefly, and sometimes exclusively, to what is not of the slightest æsthetic or artistic importance. In what are called Celtic monuments, for instance, there is no architectural articulation, they consisting of no more than so many *brute* stones,—unshapen, shapeless, or misshapen. Such things are wholly destitute of organization; hardly can they be called the work of man's hand, being merely rude blocks of stone in their natural form, testifying that those who set them up, had no architectural skill or science, and were unable to reduce them to even the simplest artificial regular form, as the Egyptians did the monoliths which they erected as obelisks. Yet though they possess neither pictorial nor architectural interest, several plates are devoted—literally sacrificed to the subject of Celtic monuments, in both the first and second series of Gailhabaud's Ancient and Modern Architecture. Surely a single plate of specimens of them would have sufficed, would have been quite as much as was their due share; whereas modern architecture has as yet come off very poorly, and must do so at last, unless the work is intended to be carried on indefinitely. A really new and fresh subject has not yet been given in it at all: they are all old acquaintances derived from other publications,—new only to those who are themselves new in architectural study. Yet if unedited subjects—such as have not yet been made known in this country at least, there is abundance,—even perplexity of choice. Out of the number of recently erected structures at Paris, there are some infinitely more worthy of notice than those which have been selected from that capital. There is for one the new church of St. Vincent de Paule, also that of Notre Dame de Lorette; and a section of the Madeleine, which seems to have never yet been so shown, would be very acceptable. The new Theatre at Dresden by Semper, the new Palace at Brunswick, by Ottmer, would be novelties worth setting before us; whereas the modern specimens selected are stale and mouldy,—are of what, in speaking of ladies, is termed a "certain age," being neither old nor young, neither lovely, nor venerable.

VIII. Architectural description is generally very dry stuff; few bring that rich poetical imagination to it, or scatter such flowers of "gay rhetoric" over it, as does the accomplished George Robins. As an example take the following effusion from his pen, which appeared the other day in the Times, relative to a place distinguished by the not particularly inviting name of Thistle Grove, but he has such a Midas touch that he makes every subject he handles glitter like pure gold.—"The house," he tells us, "is a solid piece of architecture *based* on the Corinthian order, adorned by a conservatory in capital taste, with painted glass; and within this little Elysium comfort is conspicuous in every department." An uncomfortable Elysinm, however, would be something more marvellous. "The tact that prevails is of peculiar cast; it disdains the prevailing order"! This is somewhat transcendental in meaning; and requires some cogitation to make it out. The prevailing order, by which it may be presumed the above-mentioned Corinthian order is to be understood, is it seems after all, prevailed over—even disdained by the still more prevailing tact. The tact and the order contend for pre-eminence, and poor order comes off with the worst of it, wherefore there is likely to be some disorder in the matter.—"The doors of the drawing-room are *distinguished* by plate-glass:" what an ingenious and delicate way of giving us to understand that there is no plate glass in any other part of the house! Passing by the rest of the description, it will be sufficient to give the conclusion—a climax not to be surpassed: "These apartments are so perfect that really Elysium is brought to recollection"!! As George Robins is the only mortal upon earth who *recollects* Elysium, he cannot possibly do better than enlighten the world by an accurate topographical *description* of it from his own poetico-graphic pen.

RUSTIC MASONRY.

The value of what is termed rustic masonry has been alluded to incidentally in the paper on the employment of pediments and columns in the decoration of windows; we now propose to consider the æsthetic propriety of "rustication," a little more generally.

Of this kind of masonry there are two principal species. In the one exterior surfaces of the stones are indented to resemble imperfect tooling; in the other the walls are streaked with prism-shaped channels in imitation of defective jointing. Both kinds of rustication are studied counterfeits of deformity—not merely deceptive imitations, but imitations of defects.

Were not our eyes familiar with every absurdity important into classic architecture, during what is termed the Revival of the Arts, it would not be necessary to defend by argument the condemnation of studied defects. As it is, however, it will be necessary to show in what manner the defects under consideration violate the fundamental principles of classic architecture.

The origin of rustic masonry was necessity. At a very early period of Grecian architecture, while the mechanical arts were rude and immature, the irregularities in the masonry were unavoidable evils, and the edges of the stones were chamfered to palliate in some degree the defects in the jointing. In proportion however as art advanced, the surface of the stone was more smoothly wrought, and the arris better squared, till at last the Greek masons were able to build that which is or ought to be a pleasing object to every architect—perfectly finished masonry. In this manner and no other were built the glorious temples of the age of Pericles. Many centuries however after these monuments of perfect art had been forgotten, and when also the decay of mediæval architecture evidenced how rapidly the principles of pure taste were being abandoned, an Italian architect, Brunelleschi (the same who built the cupola of Sta. Maria del Fiore at Florence, a structure in which the essential feeling of classic architecture is systematically misinterpreted throughout) re-adopted rustic masonry along with a multitude of similar solecisms, for which he has received, facetiously we suppose, the title of Restorer of Architecture.

A writer who has attempted to defend the propriety of rustic decoration, observes that though it be the imitation of defects, it exhibits a studied intention, which is a sufficient excuse for its adoption; and yet the same writer, by a singular inconsistency, condemns the use of rustic dies on columns in which, beyond controversy, studied intention is more distinctly exhibited than in rustic or tatooed masonry.* But we wish to found our condemnation of the practice not on the inconsistencies of a single writer, but on general principles.

It has been shown in a previous paper, and will therefore be taken for granted in this, that the distinctive characteristics of Pointed and Classic Architecture are multiplicity in the one, and simplicity in the other. The former style (when correctly developed) consists in the picturesque combination of a multitude of dissimilar parts; the latter exhibits but a very few forms, and those of the simplest kind. Now directly chamfered masonry is adopted, this essential character of simplicity is lost at once; each stone assumes a separate individuality and appears as if set in a frame; instead of showing but few lines the structure exhibits an infinite number everywhere intersecting each other and forming a rectangular net-work. Where columns are employed, as in porticoes, the horizontal lines of this reticulation appearing behind the columns, appear to cut them athwart, and destroy that idea of verticality which is their essential attribute.

A remarkable instance of the injury produced by horizontal lines crossing or appearing to cross the columns of a classic edifice, is seen in the church La Madeleine at Paris, certainly as far as regards the exterior, one of the most successful of modern attempts to revive pure classic architecture. The channels scored on the masonry of the cella have a most injurious effect on the character of the columns, and this injury is further increased by the imperfect (French) workmanship of the columns themselves. The shafts are composed of stones so imperfectly united that they appear encircled with a series of hoops or rings which, except the observer be at a considerable distance, cause the columns to appear discontinuous and *vertebrated*.

* We presume that there are few people who think at all on the subject who would advocate the employment of rustic dies in columns. The French apply the word "Bossage," the derivative of which signifies a tumour or hump, to projecting stones left rough in building, to be carved and finished subsequently; just as we now see in new churches, &c., corbel stones or crockets merely boasted out in the first instance and sculptured afterwards when built into their places. There is no doubt that rustic dies originated in a stupid blunder by which mere Bossages were mistaken for finished work. What should we think of the taste which would leave the irregular lumps of stone now to be seen in some of the arch-mouldings of the Palace of Westminster in their present unfinished state?

It is obviously impossible that mere streaks and crevices on a wall can be dignified by the appelation of mouldings, for they never could be made to have the same value and importance; but even if for the sake of argument, we set aside this unavoidable inferiority, is it not palpably absurd to decorate a building *all over* with mouldings? These decorations owe their effect to their rarity and their contrast with the simpler portions of the structure; and the value of them if applied every where indiscriminately is entirely lost. There is nothing in which the Greeks showed themselves more eminent than in introducing mouldings just where they were required and *no where else*. It cannot be expressed too emphatically that the whole effect of mouldings, the whole of the relief which they afford, arises from their being used sparingly and marking distinctly the outlines of separate portions of the building. If they be used otherwise confusion—not enrichment—is the result. The dressings of a doorway are not new accessories, but answer a distinctive purpose: the listel or horizontal fillet, which in a Doric order separates the triglyphs and metopes from the architrave is essentially a constinctive decoration for it exhibits the method by which the joists of the roof are supported by the columns. And in the same way we might explain the purpose of every moulding used in pure classic architecture; but mere channels cut in the surface of the walls canhot answer any purpose either real or imaginary: they do not serve to mark distinct parts of the building, for they merely separate one portion of the wall from another exactly similar portion; they do not, like mouldings properly so called, divide the building into large well-defined masses, but cut it up into a confused multitude of little parts.

If the composition of a building be properly managed it will present no large continuous surfaces which unless so scored all over appear blank and naked. If we examine actual examples of rustication we shall find it to be a mere make-shift expedient, the palliative of an evil which if the architectural grouping had been duly attended to, would never have heen called into existence. It may be safely asserted that no buildings whatever, be the style adopted, can be architecturally effective unless some portions of the building throw shadows on the remainder. This consideration is much overlooked in the present age. The great defect of modern architecture is that it seldom displays sufficient depth of shadow; it is usually to shallow and flat; it is not made up of large strongly defined masses, and the variety which ought to be obtained by depth is imperfectly compensated for by surface-decorations and minute details. Rustic work is essentially a surface-decoration, and for that reason alone, if no other existed will find little fevour among those who would restore architecture to that place among the fine arts which it once possessed.

If the architect had to deal, not with solids, but surfaces, he might take lessons of a line-engraver and the River façade of the Palace of Westminster would be perfect. A mere façade however no more constitutes a palace, than a modern church-front constitutes a church. Much more than this is necessary—especially in classic architecture of which the constituent forms are so few and simple that unless the effective disposition of light and shadow be observed, meretricious ornaments *must* be resorted to prevent the monotony and nakedness becoming absolutely intolerable. There is scarcely any thing which has more debasing and fatal influence upon art than a system of *save trouble* expedients: among them must be reckoned all superfluous surface-decorations, and especially rustication. We know but one class of buildings for which this kind of masonry is appropriate—namely, prisons, which it seems agreed should be as ugly as possible, consistently with security. In them at least rustic masonry is in sufficiently good taste and accompanied by the ornaments of skull and cross-bones, and iron chains will constitute a species of perfectly symbolic architecture which may be safely recommended to the admiration of the Cambridge Camden Society.

The subordinate decorations of a building ought, it is clear, to correspond in character to style of architecture to which they are adopted. A most important consideration under this head is that while Mediœval Architecture delights in free forms, in Classic architecture, perfect finish and accuracy are essential. An ancient church-tower of rough rubble work is a picturesque object, however simple and unpretending the architecture may be, but if the cella of Greek temple were built in a similar manner, can it be denied the coarseness of the workmanship would be totally out of character with the rest of the building. The delicacy and accuracy of outline which distinguish Greek architecture are characteristics which would be naturally looked for in a southern climate; the bold and almost rugged lines of northern architecture seem exactly to correspond to the energetic character of the people, among whom they were produced. Now these considerations, simple as they appear, are of the utmost value in determining a question like that before us. Rustic masonry displays ruggedness and coarseness of execution which, if what has just been said respecting the distinctive character of Classic and Pointed Architecture be correct, show it to be inappropriate to the former style.

This brings us to our last argument. These who defend the propriety of rustic work seem totally to overlook this consideration—that they ought to be prepared to adapt it to Pointed architecture as well as Classic, or else to point out some characteristic differences between the two styles which render rustication suitable for the one and not for the other. This however has never yet been done; on the contrary, any argument drawn from the comparison suggested would lead to the conclusion that if there be any style for which this mode of decoration is suitable, it must be Pointed architecture. The attempt to so apply it would, we apprehend, meet with universal ridicule; should not this feeling be a sufficient argument for abandoning rustic masonry altogether?

To what heresies have we not given utterance! We have condemned the use of columns which support nothing, of show sides used as masks, of pigmy columns used as window mouldings; we have declared the attempt to combine Classic and Mediæval architecture absurd; and now we include rustic masonry in our list of barbarisms. But what an amount of precedent and written testimony is against us! Does not *every one* of the things which we have condemned exist in St. Paul's Cathedral, the pride of the metropolis, and one of the wonders of the world? And yet we maintain our position, simply because we have in no case substituted assertion for argument. If we have in any case failed to prove our point we shall be very glad to be set right. That in promulgating these opinions we must contend against an enormous amount of educational prejudices is unavoidable; but it is better to do this than to let *pure* Classic architecture be forgotten in the detestation of *debased* Classic architecture which the modern improved taste for the Mediæval styles has justly inspired.

RESTORATION OF ST. BOTOLPH'S CHURCH,

Boston, Lincolnshire.

Among the Church Restorations, which the revival of Christian architecture in the present century has instigated, few deserve more the public attention than that of the Church of St. Botolph, Boston, Lincolnshire, both from the celebrity of the edifice itself, and from the extent and excellence of the work of which we make this brief notice.

The church is a Decorated structure of the 13th century, originally consisting of a nave and chancel with side aisles as at present; to this a magnificent tower in the Perpendicular style, was added in the beginning of the 14th century.

The dimensions are—	Ft.	In.
Exterior length, including buttresses	305	8
„ breadth, including porch	138	0
Interior breadth of nave	98	6
Interior height of inner roof of nave	62	8
Span of arches	18	8
Height of ditto	40	1½
Columns { Base 3 ft. 9 in.; Shaft 22 ft. 10½ in.; Cap 1 ft. 0½ in. }	27	8
Tower—		
From the ground to coping stone of lower battlement	149	11
From do. do. of upper battlement	55	4
From base of lantern to top of stone-work of ditto ..	59	2
From base of lantern to top of vanes	5	0
Whole height of tower	269	5
Tower base interior .. .. 22 ft. 5 in. ×	26	5
Glazed part of windows in tower (length)	52	0
Thickness of walls { Below windows in nave ..	4	6
Thickness of walls { Above ditto ..	4	0

Being the largest church in the United Kingdom without cross aisles.

The tower is a feature of such beauty and architectural celebrity as to need no descripition here. The octagonal lantern by which it is surmounted furnished the model from which that at St. Dunstans, in West Fleet-street, was designed.

The building is constructed of an oolite of great durability, procured, it is supposed, from the quarries at Ketton, near Stamford, Northamptonshire. The inclemencies of the weather during the winters of 5 centuries (for there are no traces or records of substantial repairs since the original erection) have but slightly impaired the general effect of the structure, though the corroding influences of damp and exposure had long been seen in the lighter and ornamental parts, and here and there on the surface of the stone work in the walls and buttresses. The circumstance, not unknown to architects in the present day, deserves a notice here, that the stones placed in a horizontal position, corresponding to that which they occupied in the quarry, have entirely escaped corrosion, while those in other positions are invariably injured). To vindicate the integrity of this chief ornament of the province of Gothic architects, the first efforts of the Restorer were directed to the mullions and arch-mouldings of the windows, and these have been replaced almost throughout with fresh stone, the glass-work of the windows being at the same time re-arranged in diamond squares, for which the oblong arrangement had been substituted at a comparatively recent date. The whole of the pannelled parapet of the nave and parts of that of the aisles and chancel were next rebuilt, the use of iron braces to compact the stone work, having caused considerable distortion, especially of the south side where the variations of temperature are more felt. The stonework on this side was so much injured as to require in a great measure to be replaced by new work, in which either copper or stone has been used. At the same time the decayed stone in the walls of the church were entirely removed and fresh stones substituted.

The restoration of the woodwork in the roof was one of the heaviest of the expenses to be incurred in necessary repairs: the ends of the larger beams being decayed to some distance from the walls, which imperfectly supported their vast bulks, sound timbers were dovetailed with that part of the larger beams which still remained sound, and along their whole length on either side strengthened by cast iron bars, which have secured the stability of this part of the structure probably for centuries to come.

The restoration necessary for the safe continuance of the structure thus provided for, the ornamental parts were next proceeded with. Four large pinnacles of 16 feet in height, and of elaborate workmanship, standing at the east and western corners of the north and south aisles were entirely rebuilt for the most part with fresh stone, and the ornamental heads of buttresses, crocketed finials, &c., throughout the structure restored or replaced.

The work of reparation was conducted by Messrs. Scott and Moffat, who have, as usual, evinced their appreciation of the spirit of mediæval architecture. The following are some extracts from the report presented by the former gentleman to the Restoration Committee. The remarks respecting the restoration of the ceilings are worthy of attention. We need scarcely say how fully we agree with the condemnation of the painted imitations of stone and oak.

The church appears, from the style of its architecture, to have been built during the reign of King Edward the Third, a period during which a great movement in the way of church building seems to have taken place throughout this district, as nearly every church in the neighbourhood seems to have been, either wholly or in part, rebuilt at the same time. It originally consisted of a nave with aisles (perhaps the largest to any parish church in the kingdom); a chancel of *three bays* only in length; a south porch of *one* story only; and a chapel at the south-western angle. It appears to have been begun and completed in the first instance without any tower—the original west wall being built perfect and distinct from the present tower, and the arch now leading into the tower having evidently been the western window, which was converted into a tower arch, by removing its tracery and mullions, and lowering the cill to the floor. At a subsequent period, probably about fifty years from its first completion, the present most wonderful and magnificent tower was added: and at about the same time the additional bays were added to the chancel, bringing the church to its present splendid proportions. The porch has since been increased in height by the addition of the chamber now used as a library, and some other minor additions have been made, and again removed, but in the main the church retains the same appearance which it must have presented on the first completion of the tower, at the commencement of the fifteenth century; and considering its age, and the neglect which it has suffered, it is in a remarkably fine state of preservation.

Nave Roof.

The nave, or central portion of the church, is the most important as being of the greatest span, and is unfortunately in the worst condition of any part of the roof, so far as can at present be ascertained. It was at first very securely and substantially constructed. The walls were tied together by fourteen beams of most ponderous dimensions, which were secured to wall plates sunk in grooves in the stone cornice, which runs in one width of stone through the whole thickness of the wall. These beams have in parts become much decayed—the ends of many having in fact completely perished, so much so, that had it not been for some rather clumsily contrived precautions, which have from time to time been taken for their support, they could not have retained their position, but must have fallen in.

The precautions alluded to, may possibly be sufficient to provide for the *immediate* security of the roof (though even of this I cannot speak with certainty), but there can be no doubt that it is anything but a satisfactory state for so essential a part of the fabric to be allowed to remain in; and that if the decay of the beams should increase, very serious consequences might be apprehended. In addition to this, I find, on a closer inspection, that the wall plates (of which there are two on each side) are (so far as I have been able to get at them) entirely perished, by which the connection of the timbers with the walls has in a great measure been destroyed. An attempt has been made (probably at a very early period) to remedy this, by the introduction of the huge iron hooks which so much disfigure the exterior of the clerestory wall; these, however, obviate the evil in a very partial manner, being ill-constructed for their purpose. There are some further defects in others of the timbers, particularly in the feet of some of the upright wall-pieces and braces, which have been partially decayed through the water having been allowed to get down into the pockets or springing points of the groined ceiling, and to saturate the masses of dust and decayed wood which have there accumulated. The extent to which this defect exists it is almost impossible at present correctly to ascertain, the parts affected being completely concealed by the mouldings of the groining; but I am inclined to think that it has not proceeded to a very serious extent.

The effect of these different defects has been to cause an undue thrust upon the southern wall, the timbers being most decayed on that side, which has occasioned a considerable curvature in the length of the wall. The wall having been, by the joint pressure of the rafters above, and the braces below, thrust outward, and partially drawn off from the ends of the tie-beams; and the enormous weight of these (each beam of itself weighing nearly three tons) being thrown in great measure upon the braces, has tended still further to increase the evil, which must even now be constantly becoming greater; and must, if not remedied, greatly endanger this part of the building. The north side of the roof not being so much decayed as the south,—and the latter having been the first to give way,—the effect upon the north wall has been of a contrary nature to that on the south; and, as might have been expected, this wall has been drawn inwards, though to a much less extent than the outward tendency of the other.

It would probably be hopeless to attempt to restore these walls to their proper position, and the utmost we can do is to prevnt their getting worse, and to do this we must endeavour—1st, to restore that longitudinal stiffness to the walls, which has been lost through the decay of the wall plates.—2nd, to complete the connection between the opposite walls, which has been cut off, partly by the same cause, and partly by the decay of the ends of the beams: and 3rdly, to support the tie-beams themselves in such a manner that by their own weight they may not be causing the failures which they were intended to prevent. The first object cannot, I fear, be effected without the introduction of new wall plates of oak, where the old ones are decayed; this appears particularly necessary on the south side. The second and third objects I should recommend to be provided for, by cutting off all the decayed ends of the beams, and replacing them with new oak, well scarfed, and with strong iron plates above and below the scarfe; and by introducing to each beam a chain truss of wrought iron, on such a construction that it would at once form a perfect tie to the roof, and would in great measure support the weight of the beam. Such other timbers as are decayed should also be replaced with new. The above repairs could be effected without materially disturbing the covering of the roof, with the exception of the gutters and some other parts of the lead work, which must be taken up and relaid.

External Stone Work.

The stone work generally is just in that state which renders it most difficult to determine the extent to which it requires reparation: it is in many parts much decayed and injured, but still not to that extent to warrant the renewal of all the decayed parts; indeed, it is generally the smaller portions of the ornamental work which are most affected; the more solid features generally remaining tolerably sound. The great object appears to prevent it from getting worse, by refixing or renewing all such parts as are in a shaken and dilapidated condition, or which are so decayed as to endanger their stability, and to replace all those detached ornamental features, such as pinnacles, finials, &c., which have been displaced or shaken, and such other injured parts as can be repaired without interfering too much with the more substantial parts of the building. There are some decayed portions of such a nature as to render it doubtful to what extent it might be prudent to attempt to replace them, such as the base-mouldings of the tower and church, and other parts which are intimately connected with the strength of the buildings, and the decay of which has not gone further than partially to efface the mouldings on their surface. No general rule can be laid down for these, but they must be viewed separately on their own merits, and according to the extent of their dilapidation, and the comparative difficulty and importance of replacing them.

I will now attempt to enumerate, in order, the several parts requiring reparation.

Clerestory.

South Side.—The upper part of the stair turret is in a very shattered state. This stair belongs to the nave rather than the tower, having in fact existed before the tower was built. It appears to be quite distinct from the tower till within a few feet of the top, where it has been connected with it by turning the stairs into those of the tower. It is this connection which has caused its dilapidation; the settlement occasioned by the weight of the tower having completely crushed it and disjointed the stone work, which has from time to time been further injured by the iron ties which have been introduced. I am of opinion that it will be necessary to rebuild it from the gutter upwards, a height of about 8 or 10 feet.

The Parapet on this side has been much injured by the undue pressure of the roof, and by the improper use of iron cramps. It is twisted into every variety of curve, and in some part overhangs considerably. Many of the stones have been split by the iron wedges imprudently used by the plumbers, and the whole is in very bad condition; so much so, that I think it necessary that it should be taken off and re-set, using new stone for such parts as are injured.

The Buttresses to the sides of the clerestory have lost their finials, and the heads are a good deal broken. The niche-heads on the same side are much decayed and broken, and all the figures but one are gone.

The Windows require considerable repairs. The mullions are many of them very much out of the perpendicular, and the tracery is displaced and broken, both by the settlement of the whole, and from the effects of the iron-work. The ashlar-work also requires to be generally repaired, that which is decayed being replaced, and the whole pointed where necessary.

North Side.—The stair turret is as bad, or worse, than that already described.

The Parapet is not so bad, but some parts at least must be rebuilt. The eastern pinnacle is not quite so bad as that on the other side.

The Side Buttresses, with their heads and finials, are not quite so much injured as those on the south side, but the finials are all gone, the niche heads are much decayed, and only four figures remain. The windows and ashlar require similar repairs, though to a less extent.

South Aisle.

The Parapet is in some parts shaken and crooked, and the ornamental tracery decayed. The part of the west end, and some few other portions, must be taken down and refixed, and the decayed parts generally repaired with new stone.

The Buttress heads have generally lost their finials, and are in other respects defective; these must be effectually repaired, and new finials provided.

The two large angle pinnacles are very much shattered, and will require very considerable repairs. That at the western angle is particularly dilapidated, almost every part of it being more or less shaken or defaced—this must in a great measure be worked anew: that at the eastern angle is not so bad, but still requires considerable work to make it perfect. The figures from the niches are all gone, and should be replaced with new ones. The greatest care should be taken in the restoration of these beautiful features, as if repaired by men who are ignorant of the style and character of the ornamental work of the period, their beauty would be entirely destroyed, which would be far worse than leaving them in their present dilapidated state.

The buttresses, string courses, and ashlar on this side are in parts decayed and defaced, and will require general restoration where injured.

The South-West Chapel.

(Now used as the Vestry and Engine-house.)

The exterior of this chapel is more dilapidated than any other part of the building; it is needless to enter into particulars, as nearly all the stone-work is more or less decayed. It is a very beautiful feature, and merits a perfect restoration.

North Aisle.

The parapet is generally substantial, and requires but little repair; excepting the exquisitely pierced parapet at the eastern gable, which requires some restoration, being in parts decayed. The buttress heads require some general repairs, and new finials throughout. The large angle pinnacle at the western end is sadly shattered, and requires the same extent of repair with that on the south aisle. That at the eastern angle has been partially repaired, but without much regard to correctness of detail; it requires still a good deal of work, and the figures should be made perfect. These, like those on the other side, require a very careful study of the details, to render them correct.

Interior.

Stonework.—I should recommend that the entire surface of the freestone work, such as doorways, windows, pillars, arches, &c., should be carefully cleaned from the yellow-wash and paint by which they are at present disfigured, and that they should, where broken or injured, be repaired and brought to a clean and perfect surface. The parts which have always been rough, should be carefully pointed, and those which have always been plastered, should be re-coloured and repaired. This would improve the general aspect of the interior more than anything, and would remove that *plastery*, disagreeable character which now so much injures the effect of the building. The great surface of the building causes this to be a rather more expensive operation, than might at first be expected, but the cost would be amply repaid by the improved aspect of the building.

The Ceilings would require painting, but on this a question might arise as to the colour which should be used. There are three ways in which it might be done. First, to paint it in imitation of stone, which I think objectionable, as being an imitation of a totally different material from that of which they are actually constructed, and one of which, in their present form, it would be hardly possible that they could have been made. This system of imitation of one material in another, is so contrary to the principles of the ancient church builders, that I think it very desirable to avoid it; particularly in restoring an old building. The centre ceiling is ancient, though not so old as the church; it was originally all of oak, though much of the boarding has since been replaced in deal. Strictly speaking, it should not be made to appear like anything but oak. The second kind of painting would be graining it in imitation of oak; this would be coming nearer to the truth than the former method, but is to a certain extent open to the same objections, as being a mere imitation. Perhaps, therefore, the most correct way would be that which was frequently used in old churches, for the decoration of wood ceilings, viz.:—merely ornamental painting, not imitating any particular material. Some of the ancient ceilings were most richly decorated in this way, and it produces a very beautiful effect. It might perhaps be practicable to take off the present painting altogether, and to restore the original surface of the wood; which would, if it could be done perfectly, be preferable to any kind of paint: in this case the oak boarding must be restored throughout. The experiment might be tried on a portion of the ceiling. This would not, however, apply to the ceilings of the aisles, which are of deal.

The Stone Floor

Is in many parts very much broken, and is throughout very damp. I should think it desirable to relay it on a good bed of concrete or shingle. I would, however, strongly recommend that the ancient monumental slabs should be retained, and that wherever they are found to be over the graves, they should be relaid in their proper places. They add much to the interest of an old church, even when worn and defaced, and should not be removed merely to gratify a love of neatness and novelty.

The Glass.

The glazing throughout is in a very imperfect state, and needs extensive repairs. It has been much weakened by the removal of the upright iron stancheons, with which every light was formerly strengthened. Its strength has also been much diminished by the use of squares instead of diamonds, which are much less capable of withstanding the effects of the wind.

These repairs may be varied greatly in their cost, according to their greater or less completeness. Should the funds be sufficient, I should recommend the whole to be re-glazed in diamonds, with new iron-work, which would vastly improve the appearance of the church, both externally and internally, which is much disfigured by the bad character of the present glazing.

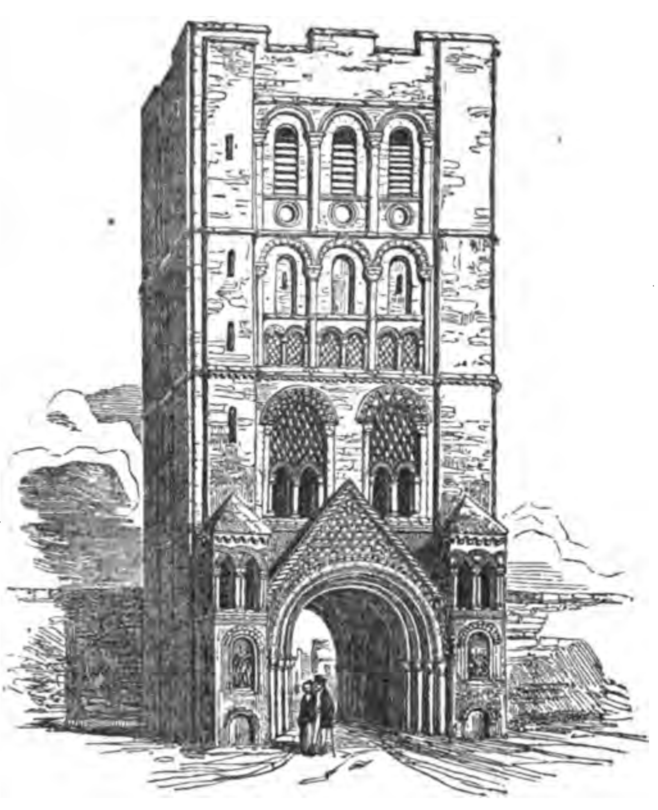
To the above suggestions I will add a few more, which though not immediately necessary are still requisite, to render the state of the church worthy of the original magnificence of the design. The first is the expediency of raising a separate fund for refitting the interior in oak in a manner worthy of such a building, the present fittings being so mean in their appearance, and absurd in their arrangement, as to destroy the whole effect and propriety of the internal character of the building. Should this be done, a more suitable situation might probably be found for the organ, which is a great obstruction to the chancel. The second suggestion is, that the external and internal restoration should be extended to the chancel, and that its beautiful stalls should be cleaned from the thick coatings of paint with which they are disfigured. I would thirdly suggest that the portion of the south-western chapel, now used as the engine-house, should be united to the remaining portion which is used as the vestry, and that the arches between the latter and the church should be thrown open, enclosing the lower part only with an oak screen. And also that the beautiful roof and other internal features of this chapel should be restored.

It would also be a most noble restoration if the present ringing floor could be removed, and the magnificent story above, with its groined vaulting and its beautiful windows, restored to its original intention. This would then be one of the finest things in existence, of this description. I was, on the first examination of this part of the building, at a loss to imagine how the bells were originally rung, but on a closer inspection, I find that they were formerly rung from the little stone galleries, which run round the second story on the level of the window cills, the ropes passing through the heads of the windows, thence for a considerable height through the interior of the wall, and over blocks or pullies set in openings in the walls of the belfry. The holes through which they passed, may yet be seen in each window-head, and also in the belfry above.

I will now conclude by strongly urging the necessity of a faithful adherence to the ancient details, which can only be done by a most careful study of their existing remains, and a comparison between them, and those of other churches of a corresponding age: without this, the beauty of the building will be destroyed, and the present work become a subject more to be lamented than rejoiced in.

I would beg to add, as a practical suggestion, that in restoring the stonework, the use of iron should be as much as possible avoided; its place being substituted by stone plugs and copper cramps, or dowells.

ST. EDMUND'S-BURY GATE-TOWER.



WEST VIEW.

Much interest has recently been excited among the reading portion of the public respecting the antiquities of the Great Abbey Church of St. Edmund, at Bury, by the Camden Society's publication of the *Chronica Jocelini de Brackelonda.* This work contains the earlier annals of the Monastery, written by a monk of the house, named Jocelyn; the reader who is curious in such matters may obtain a most vivid and graphic picture of the monastic life in the times of Kings Henry II and Richard I, by referring to the republished "Chronicles," or to the interesting and most original analysis of them in Carlyle's "Past and Present."

Of the Abbey Church little is now preserved. The magnificence which from the existing remains and the testimony of historians, we must suppose to have characterised its architecture, did not preserve it from the effect of Vandalism which accompanied the general Dissolution of Monasteries. The Norman gate tower, the Abbey Gateway and parts of the enclosure walls are now the only *vestigia* of glories which caused the historian Leland to exclaim enthusiastically, "The sun has not shone upon a monastery more illustrious, whether we consider its wealth, its extent, or its incomparable magnificence. You might indeed say that the monastery itself is a town; so many gates are there, some of them of brass; so many towers, and a church than which none can be more magnificent, and subservient to which are three others also splendidly adorned with admirable workmanship and standing in one and the same churchyard."

The growing zeal for architectural restoration has never shown itself more worthily than in the efforts now making to preserve to posterity so much of the inestimable monumental legacies bequeathed to us by our ancestors, as yet remains at Bury St. Edmunds; and accordingly we view with great satisfaction the works in progress for repairing and reinstating the Norman gate or campanile. By the terms repairing and reinstating, must not be understood merely the removal of rubbish and plaster, and the obliteration of churchwarden "beautifyings," but those substantial works also which are requisite to preserve the building from actual destruction. For it appears from a well written pamphlet now before us, in which are described the present state of the tower and the steps taken for its restoration, that it has suffered so much from violence and injudicious repairs as to threaten imminent danger by its fall. The masonry, six feet in thickness, displays numerous fissures in every part; several stones of the principal arch have fallen out; and the walls have swerved considerably from the vertical. This dangerous condition of the tower has during the last few years been the subject of serious apprehension, and attempts have been made to repair the evil, or at least prevent it from increasing. In 1811, the parish being threatened with an indictment, some injudicious patchings were commenced, and an elegant "pepper-box" was erected on the top of the tower. The fissures however increased; in 1818 two of them extended from the very summit to the lower or ground arch.

The cause of this last disaster appears to have been the vibration produced by the ringing a large peal of bells in the tower. All that was done was however to replace some of the stones which had fallen out, and to *fill up the fissures with cement!* They did "but skin and film the ulcerous place."

At length however the work of restoration was commenced in earnest. A minute report of the state of the building having been drawn up by Mr. Cottingham, a committee has been formed for the purpose of superintending the works recommended in that document, and raising funds for defraying the expenses. In the pr ogress of the survey there have been removed nearly 100 tons of rubbish and bricks, the weight of which added to the insecurity of the building. The adjacent ground has been cleared of the mean tenements with which it was encumbered, and the general work of restoration is now proceeding in a very satisfactory manner. The Restoration Committee have published "a [n] historical and architectural notice of the Gate-tower;" the profits arising from the sale of this notice are to be presented to the restoration fund. This tract, which contains a view of the tower, is exceedingly interesting, and displays great research. We should have liked however to have seen a more minute account of the nature of the reparations proposed, and of the advance which has been made in them. The following extracts from the architectural description will show how worthy the building is of the efforts made for its preservation, and may perhaps awaken the interest of some of our readers and render them anxious to aid the undertaking.

"The Tower is in height, from the plinth to the parapet, 86 feet, and in area 36 feet square. The walls, nearly six feet in thickness, are built with rubble and boulder, and faced with an ashlaring or Barnack stone. The ashlar stones, as usual in the most finished buildings of the Norman era are hewn of the size which a labourer could carry on his back, without much inconvenience, to the top of the building; and which the Norman architects, from their knowledge of the principles of equilibrium, knew so well how to apply.

"The four stories of the tower are marked on the exterior by horizontal fascias, or string-courses, of varied mouldings, which go uniformly round the four sides. The first string-course is ornamented with the chevron or zig-zag moulding, the most common and distinctive characteristic of Norman architecture. Here it is triplicate, with pendant drops somewhat resembling the guttæ of a Doric entablature. The second string-course exhibits the plain nebule corbel table; and the third is a simple tile moulding.

"In the lower story is a large archway, lofty and wide, for carriages, and in the centre of the South wall is the postern entrance, being a Norman transom doorway, the lintel of which has been cut out of solid stone. This doorway has been blocked up and hitherto unobserved, from being principally in that part of the wall which is below the present road. The principal entrance of the archway is to the West, under an elaborate deeply receding arch, with an angular pediment projecting from the face of the tower about five feet. This noble arch springs from three single pillars and a triplicate column on each side; and its mouldings are plain, with the exception of the outer one, which exhibits the double roll billet. The bases of these pillars are bold and plain, but being below the level of the road have been long hidden; the capitals are cushion-shaped and plain, with the exception of those to the triple-columns, which are sculptured—that on the South side with a representation, in bold basso relievo, of a lion destroying a serpent, which is subdued and under his feet; the other with a human figure between two winged dragons, who are biting their tails. A print of St. James's Church and Tower, engraved by Godfrey in 1779, represents the great arch as filled up, above the capitals, with masonry and sculpture, similar to that of the Abbey Gateway.

"The pediment is formed by two angular lines exhibiting the cable moulding; and the tympanum is decorated by a kind of diaper work of small segments of circles in lines, somewhat resembling scale-armour.

"The main entrance arch is flanked on either side by a square turret of three stories, terminated by a pyramidical apex. The lower story has a semicircular niche with the nail-head moulding. The second story has a similar niche with the double roll billet moulding on each jamb, and around the curve of the niche. In this niche, in the south turret, was a marble sculpture, which has been removed by Mr. Cottingham as it evidently formed no part of the original edifice. It appears designed to represent the casting of the apostate angels out of heaven.

"The corresponding niche in the north turret had also a piece of stone sculpture, till removed by Mr. Cottingham, which, though of more ancient date, was evidently an interpolation into the original building, the south jamb of the arch having been cut away to admit of its insertion. It must have been sculptured for the corner of some building, having two sides finished in high relief. It was probably found at some distant period among the Abbey ruins placed here for preservation, of which it is still worthy. The third story of each turret is ornamented with an arcade of interlaced arches springing from duplicate columns, and above is a corbel table cornice, with the corbels carved into heads, some of which are in good preservation. The whole is finished by a pyramidical apex.

"The second story of the Tower is pierced by two blank arches, each enclosing a small duplicate arch, which served as lights to a small gallery, constructed within the thickness of the wall, to permit of the warder's observing what might be going on in the town. These lights, with the exception of a small loophole in each, were blocked up till Mr. Cottingham's survey, when they were opened, and now add much to the beauty of the façade. Within the tower on this story, and near to the western piers, are small doorways on the north and south sides, which communicated by a few steps, still remaining, with the parapet of the embattled wall that surrounded the entire grounds of the Abbey. Their position is indicated on the north and south faces of the tower, by simicircular apertures in small flat buttresses. There must have been an unbroken communication along the whole line of the Abbatial walls, and these doorways show where the warders entered from the north, and passed to the south battlements. They also render it certain that there must originally have been a floor, in a line with the string-course, over the archway; and the contrivance by which it was thrown across was developed during a recent survey, by Mr. Cottingham. Equilateral spaces were left in the ashlaring on one side, for the insertion of the floor-beams, and on the other side were oblong spaces, between two and three feet high, into which the beams were dropped to their level. This plan of flooring furnished the old builders with great facilities for the repair of the floor; and avoided the necessity for those unsightly trusses introduced in modern carpentry. The architraves of the two front arches in this story exhibit some unusual and very beautiful mouldings, with a kind of arabesque and chain work, of a rare and singularly rich character. The masonry above the duplicate arches is ornamented by rows of small cones, resembling sugar loaves.

"The third story exhibits an arcade of three arches, divided into two stories by a plain transom running through the whole. The lower story is decorated by a duplicate blank arcade ornamented by a net-work. The bases of the two central pillars have groups of carved heads on their faces, and those of the lateral pillars exhibit a single head.

"The fourth story has an arcade of three lights with a circular panel in each base. The architrave is plain. Immediately above this arcade is the tile string-course marking the line of the embattlements, which are presumed to be the original finishing.

"The ascent to the embattlements is by a circular stone staircase in the north-west pier; entered through a narrow doorway in the north wall, which was originally approached by an external flight of steps."

In speaking of the manner of flooring the second story, the writer tells us in a note that in one of the caissons for the ends of the floor-beams, the workmen found the perfect mummy of a cat, who had probably taken refuge there when the building was in the course of erection, and had been immured by "the ignorance or wantonness of a Norman mason." By the licence of an abominable figure of speech, the caisson in which puss was found is termed a *cat*acomb. Mention being made of a *vesica piscis*, supposed to have formerly adorned the great arch, the following account of the term is given in a note, page 4.

"The "Oxford Glossary" describes the *vesica piscis* "as a mystical figure, of a pointed oval or egg-shaped form, originating in the figure of a fish, one of the most ancient Christian symbols, emblematically significant of the word ιχθυς, which contained the initial letters of the name and titles of our Saviour. The symbolic representation of a fish we find sculptured on some of the sarcophagi of the early Christians, [who, Tertullian says, called themselves *Pisciculi*, considering that the Christian life commenced in the waters of baptism] discovered in the catacombs at Rome; but the actual figure of the fish afterwards gave place to an oval-shaped compartment, pointed at both extremities, bearing the same mystic signification as the fish itself, and formed by two circles intersecting each other in the centre. This was the most common symbol used in the middle ages." In this country it is found in a variety of positions, and of various dimensions, both in stone and on painted glass. It is to be seen over many Norman doorways enclosing the figure of Christ; in the form of certain windows, as in the beautiful chancel window at Mildenhall parish Church; in the shape of the seals of religious houses; and to it some writers have attributed the origin of the pointed style of Architecture. French antiquaries see nothing in this oval but "a glory;" and M. Didron says the term "*vecisa piscis*," which was invented, and is abused, by English antiquaries, ought to be repudiated for its grossness. The term, however, is spoken of by Albert Dürer, at the commencement of the 16th century as one well understood at that time. An interesting paper on this subject, from the pen of Mr. George Godwin, Jun., F.R.S., illustrated by various examples of its use, will be found in the *Civil Engineer and Architect's Journal*, for April 1842."

The attempt to derive the forms of arches and plans of churches from the form of the bladder of a fish was made by Mr. Kerrich, of Cambridge, in the Archæologia. The able pamphlet from which the preceding extracts are made is, we believe, written by Mr. Tymms, the secretary to the Restoration Committee, to whom we are indebted for the wood-cut at the head of this paper.

RAILWAY SYSTEM.

The following extract is taken from the Evidence of Mr. Cubitt before the Select Committee of the House of Lords. Instead of recommending for general adoption the gauge of those railways in which he himself is particularly interested, Mr. Cubitt appears to view the question on its general merits.

I think an uniform gauge might be made throughout the kingdom, which will be better than either of the present gauges, and at a very moderate cost; at a cost which would be scarcely felt by the railway companies.

Can you make any sort of estimate of what the expense of the alteration would be?—Not a decided estimate what it would cost to alter the gauges; but I could state a minimum and a maximum. I would say it would cost from £500 to £1,000 per mile to alter the gauges. That is not a large sum.

Will you state how you would propose to alter the gauges?—It is a thing very easy to do practically; but there is a little to be cleared away first. Almost all persons think, or are taught by a certain class of persons to think, that if we were to alter the narrow gauge to a wider gauge it would be necessary to alter the existing bridges and tunnels, and so on, through which the carriages pass. Now that is not at all necessary; the carriages on the Birmingham line, and the generality of carriages almost, are sufficiently large for any gauge whatever; their post-office carriages, and their large horse boxes, and the very largest trucks, are sufficiently wide for any gauge that could be a fair workable gauge. They are big enough for the wide gauge, for I believe their post-office carriages are as large as the Great Western passenger carriages. That being premised, it will be evident that if we take for example the large carriages of the London and Birmingham Railway, which now pass upon that line through the bridges and tunnels, and pass within a certain distance of each other, and pass safely, you have only to suppose the carriages to remain unmoved sideways, and simply to imagine that the wheels are slipped right and left, brought out a little, about six or eight inches. A six feet gauge would work with the wheels set within the breadth of those large carriages, and the carriages would run exactly in the track as they did before. Consequently if you do that there is no necessity for any alteration of the tunnels, &c., about which so much objection is made. If we want to make the gauge wider, we have only to bring the rails out about eight inches on each side, and there is still plenty of room.

You only alter the under carriage?—Yes.

You put the wheels at a greater distance?—Yes; and the wheels will still be within the width of the carriages. Therefore, as the carriages pass each other now at a certain distance, they will still continue to pass each other at the same distance. The gauge will be a better gauge, and it will enable us to bring the centre of gravity of the engine lower down, as well as to widen the gauge.

Do you consider that the bringing the centre of gravity of the engine lower is a very important point for safety?—Yes; but that has never been done yet.

And practically the carriages now in use upon the narrow gauge are of such a width as to allow of that operation?—Yes. Since this thing has been rather more upon my mind I have given particular attention to it. I have now the prospect of having some control over nearly 1,000 miles of railway between the north and south, in large and direct lines, and I should be most happy if I could see my way open to improve the gauge which might be adopted in the first instance.

You have stated that there is no difficulty as to bridges and tunnels; is there any as to embankments?—There is no difficulty as to embankments; no carriage overhangs the embankments.

It ought not to do so?—I believe it never does. The means of widening that I should employ would be very simple. The rails are almost all laid upon cross sleepers or upon stone blocks; now with respect to those which are laid upon cross sleepers, it has been stated that it would cost a great deal to alter the railway because of the cost of taking it up and relaying it altogether. Now I will undertake to widen the gauge, if the road is in good order, in a very little time and at very little cost, and without disturbing a single rail on its chair, or a single chair in its sleeper. I should simply cut with a saw through the sleeper in the middle of the line, and just put each out eight inches, and then nail a short piece of wood in to connect the two parts of the sleeper. The thing would cost very little to do.

Would that leave you with a trustworthy sleeper?—Yes. And we will take the case of stone blocks. A great many miles of some of our greatest lines are laid with stone blocks; simply a small block upon the ballast. They will only want removing six or eight inches out.

The alteration, at all events, of the permanent way could be made without stopping the traffic?—Certainly. I am now going to relay a line entirely; a new set of rails and fixtures altogether, and I shall not stop the traffic; yet there are 80 trains a day on that line, or 40 each way.

Where is that? From London to Croydon.

Do you consider that there is room for great improvement in the permanent way?—The permanent way is the most defective part of the railway system.

Are not many of the rails that have been laid down upon the lines at present at work too light?—The rails are, many of them, too light; but we can always meet light rails by a different mode of laying them. But the great defect is the want of proper attention to the fastenings of the rails and the chairs. I attribute almost all the accidents that have happened from engines and wagons and carriages getting off lines of railway to the imperfect state of the road; and yet no sooner has an accident happened, than the engineers go to examine the engines, and examine the carriages, to find out what is the matter. The fact is, the cause is done away with; because it generally happens in most of those cases from the ends of the rails getting out of the joint-chairs, or the end getting loose, that it must inevitably throw off the engine, and throwing off the engine it tears up the line at the place, and we never can see it, because it is done away with. I have seen 100 yards of line torn up entirely from an engine running off the rails.

There was an accident not long ago upon the Brandling Junction, where the engineering officer sent down to report upon it stated that he could discover no cause for it. Do you think that it probably was from some defect of this kind?—No doubt of it. I have witnessed an accident upon that very line. The engine and carriages tumbled over one another, and the line was torn up for 100 yards; but I knew from what had taken place just before upon the line that that was from the defective state of the road.

And you think that in the case referred to in the preceding question, when it was clearly proved that there was no fault in the arrangement of the points, or in the engine, in all probability there must have been some fault in the permanent way?—Yes. When the permanent way is a little defective the shock becomes very sharp, and the rails, resting in an imperfect chair, are apt to work out. I am now having chairs made with a very long socket, to prevent the ends of the rails getting out, for when one of those ends gets loose it jumps up or gets sideways, and it must throw the engine off, and in doing that it must break the chair to pieces.

One of the witnesses has stated, when the Gauge Commissioners were down near York, the engine they had went off the line, and was upset; and that that was occasioned very much by the great length of the engine; and that they found on the rails the marks showing where it had struck, by the great sway backwards and forwards; till it found a defective rail, and then it went off?—I have seen rails and sleepers moved out of their place from the oscillations of an improper engine upon a badly laid road. I mean an engine not well balanced, and having too much play.

Do you think that if it were possible to get the weight lower down, by a greater width of gauge, it would in a great measure obviate that?—The difficulty would be obviated altogether by a wider gauge, a better road, and an improved engine. We might then go 100 miles an hour with as great safety as we no now do 30; there is nothing to limit the speed.

Is not it from the increased rate of speed that engines so frequently burst?—No; it is a small tube that bursts; a tube about two inches diameter. There are about 90 to 120 of them in each boiler. After they have been used some time they wear thin, with the draught and the fine particles of coke; one tube may be a little defective in its making; and when a great pressure of steam and the action of the wear upon them cut them thin, sometimes they will burst, and the water will flow into this tube, and the steam will flow out, and stop the engine going.

Does that ever happen with any but fast trains?—Yes; but you do not hear of it. Indeed it would be rather less likely to occur with an increased rate of speed, because when the engine is driven very fast there is less pressure upon those tubes.*

When the directors of a railway are desirous of remedying the want of power, what is the expedient to which they have recourse?—To build larger and more powerful engines. They require to be made either longer or larger to make them more powerful. Some of the engines on some of the lines, I believe, are worked up to more than 100-horse power. That is an enormous thing in that space.

If for the purpose of increasing the power the expedient adopted is that of lengthening the engine, does not that increase the danger upon the narrow gauge?—No; not the lengthening it, but the raising it higher makes it more dangerous. They have to make them higher when they make them larger and more powerful.

A witness stated the other day, that projecting the engine very much over the wheels, if they could not extend on account of the turn tables, caused oscillation from the weight being fore and aft?—So it does. That was the great defect of the engines on the Eastern Counties Railway, and caused the late accident on that railway. In making them longer it brings the wheels too far apart, and there was an overhanging weight.

Would not also the great length of the engine be inconvenient in a curve? The longer engines are between the wheels the more they are likely to impinge upon the rails in going round very sharp curves; but that is obviated in America upon another plan, and I recommend the plan very much to the Gauge Commissioners. I told them that all those things may be overcome with proper arrangements. On narrow gauge railways they cannot go so fast as on broad, because they cannot get as large driving wheels with safety, without carrying the centre of gravity too high. I could make an engine of any length which should be better adapted for going round curves than any engines now are. For instance, an engine 20 feet long might be made perfectly safe and steady with very large driving wheels upon a narrow gauge, even with wheels as large as the Great Western wheels, simply by having what the Americans call a "Bogy" carriage—a small carriage with four low wheels moving upon a centre horizontally. Imagine a small truck with four wheels upon the line; then imagine another small truck behind it with four wheels. Now those wheels and axles would be stronger than the present ones, and lighter. Then, if we support a very long boiler indeed upon those trucks, the trucks with four wheels can each turn independently at each end. Then anywhere between those we may have large driving wheels without flanges, there being eight other wheels to take the weight at both ends. We might have the driving wheels of any height; then they would turn round curves very rapidly indeed. I explain this to show that there are no insurmountable difficulties mechanically, for the wheel might be improved in every respect.

Still you would recommend, as the best security for safety, an alteration of the narrow gauge to a wider gauge?—Yes; to a reasonable gauge. The lower the centre of gravity the greater the safety.

Will you state what width of gauge you would consider the best?—A six feet gauge I take to be about the best that could be adopted, or it might be five feet eleven or six feet one; a few inches more or less is of no consequence, but six feet is about the best gauge; it is an integral measure, it is an even measure, it is an easy measure, and it is of easy reference, and well understood.

Is that the gauge which was recommended by the commissioners upon the Irish railways?—They recommended six feet two inches; but I do not know why the two inches were put on.

Have you ever made any estimate of the cost of altering the carriages or wagons?—The first, second, and third class carriages will cost about the same sum almost to alter. The average passenger carriages may be altered from a four feet eight inches and a half to a six feet gauge at an average cost of £30 each, and I think for less.

By multiplying the number of carriages constituting the stock of the different companies at present at work you could ascertain the total cost of altering the carriages?—Yes; and it would cost £350 to £400 to alter an engine and tender, leaving the working parts exactly as they are now.

So that it would be perfectly possible to ascertain the total cost of the alteration?—Yes.

Have you ever turned your attention to the means of providing the necessary sum to defray the expense of the alteration?—I think it should be paid for partly by time gone by and partly by futurity; that is to say, money might be taken up at a certain rate of interest for doing this work, either from Government or by transferable bonds, payable off by lot; any thing of that sort. Then the works should be paid for as they were done. Whatever they cost should be apportioned, as nearly as it could be, over about 40 years; that is, 20 by-gone years, and 20 future years of railway extension; and all newly-made railways should pay their quota of the alteration as the past had paid; so that in 40 years, or 45 or 50 years, the thing should be paid off, and the work all done. The work should be all done at once, for the sake of the public. It would be paid for in a long time, for the sake of the parties. It would not tax any company harshly to make the alteration, and therefore they could not complain of it in point of expense. All the new railways would have to pay a quota for the same thing, although they would make their gauges right in the first instance. I think that is but fair.

You have no doubt that it would be of considerable advantage to the country in many points of view that there should be but one uniform gauge?—There can be no doubt about that.

Both for traffic and for the military defences of the country?—Yes; in every respect; I will not make one exception, because I do not think one can be made. But I should be sorry to see other narrow gauge lines granted if there is likely to be an alteration, because there will be many miles of new railway; many more than are made; I think twice as many.

You think this is a good opportunity for making the alteration?—I think if the thing is ever to be done there should not be a season lost, certainly. I think the thing may be easily done, and economically done, and done without loss to the public and without loss to the companies, and in a very short time, and at a very moderate expense.

You think it very important that if anything of the kind is contemplated it should be settled with the least possible delay, in consequence of the numerous railways now in progress?—I think so. It is a very serious subject, but almost all parties who speak upon the subject are in some way or other interested in this, that, or the other gauge.

You think it is very important that it should be practicable to go at high speeds on railways for persons who have to go great distances?—I think that is evidenced every day, for if we put on express trains every day, and advertise to go at 60 miles an hour, people will risk their necks as long as you will carry them, and therefore it is highly necessary for the safety of the public (for people will not take care of themselves) to have all the machinery of the best kind, and if the permanent way is perfect, and the gauge a proper gauge, there is nothing to limit the speed but the resistance of the atmosphere. That I am sure of, as far as safety is concerned there is no danger.

No greater danger in going 60 than in going 30 miles an hour?—On a perfect railway there is no more danger in going 60 miles an hour than in going 30.

But the mere alteration of the gauge to the improved width which you propose to make it would not at once attain the increased speed which you hope to attain?—It would be the greatest step to it.

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* It is asked with great deference whether the opinion be quite consistent with known mechanical principles. The pressure on the tubes will generally increase with an increase of velocity!—Ed

GASES AND EXPLOSIONS IN COLLIERIES.

The following interesting document is the report of a commission addressed by Lord Lincoln to Sir H. De La Beche and Dr. Lyon Playfair, for the purpose of obtaining information as to the best means of preventing, or mitigating, the fatal effects which are so frequently the result of the generation of noxious gases in coal mines:—

My Lord,—Having, in conformity with the instructions contained in the Earl of Lincoln's letter of the 27th of August, 1845, directed our attention to the composition of the gases evolved from coal beds, to the mode of ventilating collieries, and to the subject of explosions in them generally, we have the honour to submit the following statement for consideration.

With respect to the gases evolved from beds of coal, they may be viewed as the result of the continued decomposition of the vegetable matter from which coal is derived, a decomposition which may be regarded as still in progress under favourable conditions. Omitting the mineral substances, which, when burnt, are known as ashes, coal is essentially composed of carbon, oxygen, hydrogen, and nitrogen; and the quality of the coal depends upon the relative proportion of these ingredients. When the proportion of the carbon to the oxygen and hydrogen does not exceed about 75 per cent. the coal, in common terms, is called "bituminous;" when the carbon amounts to about 85 or 90 per cent. it is termed "anthracite," or stone coal: or, in other words, the most advanced state of decomposition of the original vegetable matter bears the latter name.

During the decomposition a portion of the carbon is removed by its union with oxygen, forming carbonic acid, and another portion by combining with hydrogen, as carburetted hydrogen. Thus by continued decomposition the carbon gradually becomes a more important constituent in the remaining part of the original vegetable mass. The change from bituminous coal to anthracite can be produced artificially, and in a manner to illustrate the subject, considered geologically.*

Though carbonic acid is, no doubt, found in many of our collieries in such a manner as to show it to be derived not only from the lights, horses, and workmen employed, but also to be partly the result of the progressive decomposition of the coal, it is with the carburetted hydrogen, or firedamp, as it is termed, that the collier has chiefly to contend. This comes upon him in various ways. Some coals more readily emit it than others, and hence they are locally termed fiery seams, beds, or veins. From some coals it would appear to escape more generally from the mass of the bed than from others, the gas gradually accumulating from the discharge over a wide surface. Other beds, again, are more fiery in the softer than the harder portions, and where joints or fissures are common. When two or more seams of coal, having different qualities, make up a workable bed, one will sometimes be more fiery than the other. Again, much depends, all other circumstances being equal, upon the kind of roof or covering rock of a coal-bed. If this be sufficiently porous, as many sandstones are, the conditions for the escape of the firedamp upwards through superincumbent rocks are more favourable than where the roof is composed of clay or argillaceous shell.

The dislocations of the strata termed "faults" or "troubles" act frequently also as channels for the passage of the firedamp into the works, as they conduct the gas from coal seams beneath, which may be highly charged with it, although the seam under work may be free.†

Although we may regard a large proportion of this gas as previously formed, and ready to escape when the necessary conditions, such as those of colliery workings, present themselves, we can scarcely suppose that carburetted hydrogen is not also formed during the time occupied by the progress of the same workings, much being evolved from the older portions of them. The manner in which splinters of coal are thrown off during the cutting of some beds has led to the hypothesis that the gas may be present in a liquid state, produced by condensation, so that when the needful pressure is removed during the progress of the work, the sudden expansion of the "fire-damp" from a liquid to a gaseous form throws off the fragments. The force also with which the gas bursts suddenly forth from clefts or joints in some beds of coal is so considerable as to prove much previous compression, particularly when those bursts or blowers last only for a short time. When they continue for protracted periods, we may infer a more constant supply from continued decomposition of the coal, though the first sudden burst would point to compression. It has been inferred that the small cavities in which the fluid gas is confined can be detected by the microscope in some coals. It is probable that soft places, the sides of joints and fissures, and the walls or faults, are more favourable to the decomposition of the coal than its more solid portions.

The escape of fire-damp is generally influenced by the barometrical state of the atmosphere, especially when much of the gas has become accumulated in the wastes or goafs. This is more or less experienced in all pits; but one striking case was pointed out to us by Mr. Jobling, of Jarrow Pit. In a pit of which he is the viewer the gas issues from cracks in the roof of the seam, and in low states of the barometer is evolved in considerable quantity. When the barometer is high, instead of this issue of gas, there is a sensible current of air which enters into the cracks. When this inward current takes place the pit is worked with naked candles, but when the evolution of fire-damp commences Davy's lamps are employed.

Assailed in this manner by a gas which, when mingled with atmospheric air in certain proportions, is highly explosive, a knowledge of its exact composition becomes a subject of great importance to the collier, since effective precautionary measures, more especially as regards the lights employed, must necessarily depend upon such knowledge.

Dr. Henry, Sir Humphry Davy, in this country, and Bischoff and others on the continent, have examined into the nature of the explosive gases of mines, but with results differing from each other; for while the English chemists found them to consist of carburetted hydrogen, with little or no admixture, the continental chemists have described them as very complex mixtures of olefiant gas, carburetted hydrogen, carbonic oxide, hydrogen, nitrogen, oxygen, and carbonic acid. On such a point ignorance would be culpable; and we were instructed to bring our knowledge up to the present advanced state of chemical analysis. Whilst we were engaged in this research, Professor Graham made a report to the Chemical Society on the same subject. The previous investigations of this chemist had rendered him well fitted for the task, and the results of his inquiries (according, as they do, with our own) amply guarantee that the subject, as far as relates to this country, may now be considered as decided, and show that the importance of an exact determination had simultaneously engaged the attention of the public.

It is unnecessary to describe in detail the methods which we pursued in the analysis; it may be sufficient to state that we adopted the methods mentioned in a report to the British Association on the analysis of gases by Professor Bunsen, and one of us. We may, therefore, at once tabulate our results, merely stating that we have devoted much attention to this investigation, so as to remove doubt upon a subject so important to the interests of the public. The gases were collected in various ways, some from blowers, others from the freshly exposed surfaces of the coal while the gas issued out with a singing noise, others from the explosive atmosphere of pits.

Gases.	Wallsend, from Pipe on Surface.	Wallsend, Bensham Seam.	Jarrow, Bensham Seam.	Hebburn, Bensham Seam. 161 fathoms deep	Jarrow, Low Main.	Jarrow, 5.4 Seam.	Gateshead, Oakwell Gate, 5 4 Seam.	Coal 24 ft. below Bensham Seam, Hebburn Colliery
Carburetted Hydrogen	92·8	77·5	83·1	86·0	79 7	93·4	98·2	92·7
Nitrogen ..	6·9	26·1	14·2	12·3	14·3	4·9	1·3	6·4
Oxygen ..	0·0	0·0	0·6	0·0	3·0	0·0	0·0	0·0
Carbonic Acid	0·3	1·3	2·1	1·7	2·0	1·7	0·5	0·9
Hydrogen ..	0·0	0·0	0·0	0·0	3·0	0·0	0·0	0·0

The general result of this examination is, that the only inflammable constituent present in the explosive gas of collieries is carburetted hydrogen or fire-damp; there is not a trace of olefiant gas, and only in one out of the eight gases analyzed is there hydrogen. It follows from the previous analysis that the issue of fire-damp into the atmosphere of a mine must deteriorate the air, by adding an undue proportion of nitrogen gas; in one case this gas amounts to 21 per cent. During an explosion the oxygen necessary to the respiration of the workers is removed by uniting with the carbon of the fire-damp, and thus producing carbonic acid, a gas most fatal to animal life. This carbonic acid, mixed with the residual nitrogen of the atmosphere, and that present in the explosive gas itself, forms what is termed after-damp, which produces effects more fatal even than those arising from the explosion. It often happens, that after an explosion a sufficient quantity of oxygen remains to support the respiration of those who survive its effects, were it not for the presence of carbonic acid. This gas, when present in no greater proportion than one or two per cent., is capable of producing the most injurious effects. It has therefore been suggested, that cheap mixtures, made of substances capable of absorbing carbonic acid, such as glauber salts and lime, would prove useful to those who try to aid the sufferers after the explosion. Such a mixture placed in a coarse bag and applied to the mouth would effectually absorb the carbonic acid, and prevent it exercising an injurious effect on respiration. Certainly the want of some such precaution in the case of the Jarrow explosion caused the death of a very meritorious man Jacob Difty, the overman of the pit.

An explosion is, however, generally attended with much more complex results than those described as attending the combustion of carburetted hydrogen. The amount of fire damp which may be first ignited may be trivial, and yet produce the most disastrous effects. From its lightness it accumulates at the upper part of the passages, and diffuses with considerable difficulty, often acting as a train, and communicating the explosion to the pent-up reservoirs of gas in the goafs. It is thus that in almost all accounts of explosions two are generally described as taking place; the first local, and at the seat of the explosion; the second more general, and aided by any accumulation of foul gas in other parts of the pit. In the case of Jarrow, the heat attending the explosion was so intense as to have thoroughly coked to the depth of nearly one quarter of an inch the coal lining part of

* Specimens in illustration of this, made by coking coal in a very gradual manner, are deposited in the Museum of Economic Geology.

the walls of one of the passages; an effect which could scarcely be conceived without supposing that the flame played for some time upon it with the intensity of a blow-pipe flame. The surface of coal thus acted upon was so considerable that the amount of explosive gases evolved during this coking must have been far from insignificant, and may have aided the explosion itself. Add to this, that the first effect of the explosion is to blow up and ignite the immense quantity of coal dust lying about the pit, and not only produce from it an evolution of gas, but also occasion the production of much carbonic acid. And it cannot escape attention that the whole subject becomes involved in much complexity. It is known that a certain mixture of air with carburetted hydrogen prevents its ascendibility; and, in the case of pure carburetted hydrogen, the proportion has been ascertained to be not less than 15 times its own bulk. But the variation in composition of the fire-damp of different mines, the uncertain modes of its issue, and the absence of any ready means of ascertaining its quantity, prevent any general rule being given as to the amount of air which should be thrown into mines to prevent the atmosphere ever attaining the explosive state. All this must be determined by practice to suit the varying conditions of different mines. It is certain that improvements might be made on the rude methods now in use for effecting the necessary mixture. The fire damp being, from its lightness, at the top, is not quickly, influenced by the current of cold heavy air descending the downcast shaft, and circulating through the passages. It is therefore not unfrequent to see colliers flapping their jackets among this light gas, so as to dilute it with the sufficient quantity of air, and thus disturb the train of communicating gas which, in a foul state, may connect two dangerous parts of a pit. Mechanical contrivances, such as fanners, would more efficaciously produce the result than the inefficient extemporaneous means referred to; but, in general, such arrangements are only necessary when, from a defective ventilation, the current of air through the pit is not sufficiently strong.

Various artificial means had been proposed to facilitate the withdrawal of fire-damp from a pit. Suggestions have been made to take advantage of the lightness of the gas by favouring its ascent to the upper parts of the pits, and drawing it off by special air ways. Pipes let down into the wastes have been proposed for the same purpose, while other suggestions have been made of pipes to blow in air at the tops of the passages, so as to cause the dilution of the gas.

We do not stop to consider these plans, because, as we have already stated, the conditions under which coal is worked are so numerous, that a plan which might prove useful in one pit would be wholly inapplicable and sometimes positively injurious in another, and the legislative application of any one plan might prove highly prejudical to this great branch of national industry.

In 1835, a Select Committee of the House of Commons was appointed to inquire "into the nature, cause, and extent of those lamentable catastrophes from explosions which have occurred in the mines of Great Britain, with the view of ascertaining and suggesting the means of preventing the recurrence of similar accidents." Numerous witnesses were examined before this Committee, a body of important evidence collected, and a report published in the same year,—a report replete with valuable information, and to which we would wish to refer for ample details connected with the general mode of working collieries, especially in the north of England. The Committee observe, on the subject of colliery explosions, that while the loss of interrupted trade by these accidents is enormous, "it is nevertheless rather with reference to the cause and interest of humanity than in a pecuniary point of view that this inquiry has assumed its great importance." This Committee did not recommend any remedial measures.

The difficulty experienced of obtaining accurate information respecting the number of lives lost from colliery explosions within a limited period is nearly as great at the present time as it was in 1835. And it should be borne in mind that the number of lives lost by the great explosions, those which chiefly become known and arrest public attention, by no means affords a correct view of the collective loss of life sustained by colliery explosions generally, including the minor accidents not commonly heard of beyond limited districts; neither does it represent the injury sustained by these explosions, short of the loss of life, but from which many persons are more or less disabled.

The Committee were enabled to ascertain that during the 25 years preceding these inquiries 2,070 persons had perished from colliery explosions; and they considered this number much underrated. During the last 10 years the rate of loss of life from this cause has certainly not diminished. The experience of the past year has shown that considerably more than 100 persons have been known to have thus perished.

It has so unfortunately happened that, during the few months we have been engaged upon this inquiry two explosions, one at Jarrow in Durham, and the other at Risca, in Monmouthshire, have together deprived 76 persons of their lives, 41 having perished at the former and 35 at the latter.

By direction of Sir James Graham and the Earl of Lincoln, we were commissioned to ascertain the causes of both explosions. It so occurred that, being at that time in the south of Ireland, engaged on the duties of the geological survey, Sir Henry de la Beche could not reach Jarrow in time for the inquiry, and therefore the investigation into the cause of the explosion at that place devolved upon Dr. Playfair, who, under these circumstances, availed himself of the services of Mr. David Williams, at that time one of the geologists attached to the geological survey of Great Britain, and well skilled in coal mining, but now in the service of the East India Company, examining the coal resources of India. The results of this inquiry are given in the accompanying report by Dr. Playfair.

Immediately after the explosion at Risca on the 14th of January, 1846, instructions were again received to proceed without loss of time to that colliery. Dr. Playfair being, however, so engaged upon duties in London, that he could not readily proceed to Risca, the investigation was undertaken by Sir Henry de la Beche, aided by Mr. Warrington Smyth, mining geologist to the geological survey of the United Kingdom, who was in every respect qualified for such an inquiry. The accompanying report contains the results of this investigation.

During these inquiries it became very important carefully to consider the kinds of lights employed in collieries, and the usual regulations respecting them. The subject was not new to us, since for more than 25 years the mode of working collieries in different parts of the United Kingdom, as also on the continent of Europe, had engaged the attention of one of us. On the subject of safety lamps, of lighting generally, and of the regulations connected with it, the Committee of 1835 collected a large amount of evidence, more especially regarding our northern collieries. In the report of the South Shields Committee of 1843 there is also much information on this head. To these reports, therefore, we would wish to refer for sufficient information on the subject.

The Committee of 1835 pointed out that more persons had lost their lives from colliery explosions for the 18 years succeeding the introduction of the Davy safety lamp in 1816 than in the 18 years preceding the invention, and accounted for this fact by the working of numerous "fiery" seams of coal, which had, in consequence of the assumed security of that lamp, been undertaken, and by the abandonment of many precautions considered requisite when candles were commonly employed in collieries.

As much doubt has been thrown upon the real safety of the Davy lamp, it is but justice to the memory of Sir Humphrey Davy to state that he was perfectly aware that, if a proper mixture of fire-damp and common air were thrown against the lamp with sufficient force to project the flame upon the gauze cylinder, it might communicate with the flame, and cause explosion. Mr. Buddle, in his evidence (Report of Committee of 1835, Nos. 2,226 and 2,227), clearly shows this to have been the case. He mentions an experiment at Morton West Pit, were a very powerful blower from the shaft was tried with the lamp, when the flame passed and the blower was fired. Sir Humphrey Davy then, addressing Lord Durham, and many other persons who were present, said, "Now, gentlemen, you see the nature of the danger to which you are exposed in using the lamp, and I caution you to guard against it in the manner I have shown you. This is to show the only case in which the lamp will explode; and I caution and warn you not to use it in any such case when you can avoid it without using the shield." The shield recommended was one of tin, inside the cylinder, to prevent a current of fire-damp from acting on the flame. Mr. Buddle stated before the Committee that in the lamps used in the collieries under his management the shield passed from one-half to two-thirds round the inside of the cylinder, and, being bright, reflected the light to such an extent as to be more advantageous than a glass cylinder inside that of wire gauze, a contrivance often recommended to obviate the risk of currents of fire-damp.

Dr. Pereira, at the request of the Committee of 1835, experimented upon many lamps before them, and passed the flame through all those tested, except that of Messrs. Upton and Roberts. The experiments have been repeated at the Museum of Economic Geology, by Dr. Pereira and by ourselves, with the ordinary Davy lamp, and with the same results.

There can, therefore, be very little doubt that the flame can pass, and explode fire-damp adjacent, if the current be sufficiently strong, and no protection be afforded either by a metallic shield or by an internal glass cylinder. The question as to the amount of current required seems not so well ascertained. Mr. Buddle considered that the blowers would rarely be found strong enough. Mr. Stephenson supposed that many accidents may have happened by the falling of the roof producing a sudden rush of explosive fire-damp. It will be obvious that the same effect might be produced by the careless swinging of the lamp with the required velocity through an explosive mixture of fire-damp and air, or from the lamp being so jerked out of a collier's hand, by an unlucky fall, that the cylinder presented the necessary front to the same compound.

Without desiring, in the slightest degree, to cast unnecessary doubt on the safety of the Davy lamp, since we consider its cautious use an immense boon to coal mining, and believe that much additional security is obtained by the proper use of the original Davy, or of its improvements, it can scarcely be denied that far more care in the use of safety lamps is needed than is commonly employed. Although shields or glass cylinders are used in some localities they are never employed in others; and the bare single cylinder of wire gauze, not always properly manufactured, is the only form in which the Davy lamp is known. And it should be observed that, with a few local exceptions, the Davy lamp is that commonly employed. Numerous modifications, and in some cases improvements, of the safety lamp have been made, but, either from the expense, or want of simplicity in management, have never come generally into use.

The colliers, by their usual mode of carrying the common Davy lamp, certainly, under ordinary circumstances, guard against the passage of any current of fire-damp sufficiently strong to pass the flame, by placing the lamp within their jacket flaps, or carefully protected in some other manner. Abundant carelessness is often, however, apparent; and, when the collieries are viewed as a whole, unnecessary risk is too common, especially when it is recollected that the fool-hardiness or carelessness of one may destroy the lives of many.

To those who have, during many years, had occasion to visit collieries in different parts of Great Britain, the thoughtless daring of many of our colliers, and their frequent carelessness under danger, must be familiar. They will often, in an endeavour to execute more work in a given time, when paid by the ton or piece, remove the covers of their lamps, or employ a candle at a risk. Some even prefer a candle to ascertain the presence of fire-damp, since by it they more readily see the change in the flame. In many districts, though in some they are anxious to employ the safety lamp, it requires much trouble on the part of the managers to prevent the continual use of candles in suspected places before the danger becomes known to them. The less light afforded by lamps is considered a great drawback to their use when it can be avoided. Many most careful men, no doubt, anxiously watch over the common danger, and great precautions are taken by many coalowners and workers; but looking at the subject generally, and without reference to many exceptions, especially to be found in the north of England, the want of system in the management of lights, and in due precautions respecting the kinds employed, can scarcely escape the observation of those whose opportunities have been sufficiently extended.

When we consider that the safety lamps have now been in use for so many years, causing security in all cases where proper care is employed, although they may not be absolutely safe under unusual circumstances, their utility appears sufficiently sanctioned by experience to make them the subject of legislative enactment. The evils complained of in the modifications of the Davy lamp are, that, while they add to the security, they diminish so much the amount of light, as to render them practically useless. These are described in the report of the Select Committee referred to. A new modification of Dr. Clanny's lamp, invented since then, is not subject to this fault, and in principle is an elegant application of the safety lamp, and consists of a wire-gauze cylinder, having beneath a thick glass cover to the lamp, which only ascends till it meets with the gauze; the thickness of this glass is supposed to free it from accidents, and, whilst strong enough to bear a considerable blow, it is sufficiently well annealed to resist sudden changes of temperature. But whether, in a manufacture so uncertain as glass, these conditions can always be attained, is questionable, and at all events has not been sufficiently tested by experience to induce the coalowners to employ this lamp in their mines.

It has been at various times proposed, during the last eight years, to employ electricity as a means of lighting collieries. The electricity, streaming between two charcoal points from a Grove's or Bunsen's battery, affords a light of much beauty, and perfectly safe, if completely surrounded by glass, but capable of igniting an explosive mixture if exposed. Professor Grove has constructed a lamp on this principle, which he kindly prepared for us, and which we have examined in action. It consisted of a box, containing four galvanic cells, and the light was obtained by the passage of electricity between two coils of platinum wire. These were surrounded with glass vessels; the inner one for the purpose of isolation, the exterior one being filled with water, so as to destroy the light should the inner glass vessel be broken. The light given out was rather more than that of a miner's candle. This, certainly, is a safe lamp, but in its present state still unfitted for the purpose of the collier as at present arranged. The acids, sulphuric and nitric, render the lamp so inconveniently heavy, that both hands must be used in carrying it; besides, from not being covered, the spilling of these corrosive liquids on the persons of the miners could scarcely be avoided. The water in the exterior vessel soon becomes heated, and ultimately boils, and the light only lasts in proper strength for two or three hours. There must, therefore, be considerable modification in this lamp before it can be rendered available for ordinary mining purposes, which we may readily expect, from the acknowledged talent of its inventor.

The means of obtaining the needful lights in collieries, though most important, would still appear subordinate, as has, indeed, been before remarked, to such a system of ventilation as should not expose men in such large portions of a colliery as is now frequently the case to the risk of death from explosion (the greater proportion, and often all, perishing from the carelessness of one man), or to unforeseen accidents under the greatest precautions in the use of lights. The too common use of single shafts in collieries, in cases where others might have been sunk, the single shaft divided into two or three portions by wooden partitions named brattices, a down current of pure air descending through one division, and the foul air from the colliery workings rising up through another, has often been reprobated. The Committee of the House of Commons of 1835, and many important witnesses examined, animadvert upon this practice; and the bad effects of this system is pointed out by the South Shields Committee in their report of 1843.

In a single shaft, as has been often remarked, the ventilation may be cut off from the workings of a whole colliery in an instant by an explosion sufficient to destroy the doors or partitions directing the air-courses, the air merely going down one division in the shaft and rising through another, when the brattices may not be destroyed by the explosion, and a kind of draught kept up. Thus all not destroyed by the explosion perish in the mixture of nitrogen and carbonic acid, known as after-damp, to which no fresh air can reach. In the explosion at Jarrow Colliery there was only a single shaft communicating with the workings upon two beds of coal one above the other, and the lower part of the brattice in the shaft was so shattered by the late explosion in it, that Dr. Playfair and Mr. Williams, in their descent into the pit, then containing a large amount of fire-damp, had to be let down a considerable distance by a loop in a rope. In this explosion the upper portion of the brattice fortunately remained, and thus the lives of many of those engaged in the upper workings were saved, although several perished.

Even in a double shaft, or two shafts not far distant from each other, if the air be not made to course for a considerable distance amid the workings by a firm thick parting of coal, any needful perforation in the parting for the progress of the colliery being firmly built up, a whole mass of workings may, by an explosion, be suddenly cut off from ventilation, and numbers of persons, not killed by the explosion, perish by the after damp. This was the case at the late explosion at Risca. It should, however, in this instance, be observed, that the colliery was, as regards ventilation, in a transition state, a more perfect arrangement for ventilation being in progress.

Great improvements were introduced in the ventilation of collieries in many districts, when the course of air was quickened by means of a furnace established near the bottom of the upcast shaft, or that through which the foul air passes outwards, and more particularly when, in the north of England, instead of permitting the air introduced by the downcast shaft to pass slowly and imperfectly along a course of 20 or 30 miles of passages, it was split or divided into separate courses, from two to six miles in length. Those, however, who may possess an extended acquaintance with our collieries in different parts of the country cannot but be aware, that, as a whole, their general ventilation is very imperfect, good as it may be in some collieries, particularly in certain districts.

When it is considered that coals are worked in the United Kingdom under every variety of condition,—from levels driven into mountain sides to pits sunk to great depths through masses of superincumbent rocks,—in beds ranging from a vertical to a horizontal position, and even contorted and bent,—sometimes traversed by faults, at others free from them,—the beds near the surface in one place, and ranging beneath mountains in another,—in fact, under a great variety of geological conditions, it is not difficult to see that many plans which have been suggested for the working of collieres, good as they may be for some localities, would be inapplicable generally, and would indeed fail, except under the conditions fitted for them.

So various are the conditions under which collieries are or can be worked in the United Kingdom, that we would suggest for consideration, if legislative measures should be deemed advisable, and an extension of the principle which regulates the employment of women and children in our mines, and the labour in our factories, be thought good, that effective discretionary powers should be vested in properly qualified persons, appointed in convenient districts, so that the needful adjustments to conditions may be effected, and no single system be attempted inapplicable to our collieries as a whole.

Any general system of legislation for conditions so different could only be productive of failure or of injurious consequences, both to owners and workers; but a local examination and inquiry, with power to adjust to special conditions, would, we apprehend, remove the difficulties which the Legislature has felt in dealing with interests so important.

Jealous as the coalowners should properly be of any undue intermeddling with their collieries, it may nevertheless be true that a judicious system of superintendence in a district, by which the proper ventilation of collieries, efficient knowledge on the part of subordinate agents, and proper punishment for fool-hardiness or carelessness on the part of the colliers may be secured, would be a great advantage to them individually and collectively, and be the saving not only of lives but of much capital, securing them, in the case of accidents, from many an unjust accusation for neglect.

On the other hand, careful but not overmeddling supervision would afford confidence to the collier. Proper persons being appointed as superintendents (and, if improper, their deficiencies would soon become apparent, and their removal the consequence), he would feel that he has the advantage of the existing knowledge of the day brought to bear upon the particular conditions under which the colliery in which he labours is worked. In some districts the working collier is far better informed upon the general principles which should receive attention than may be commonly supposed, and he would feel far more secure from danger than he now does, if assured that the State was not neglectful of his safety.

Though several collieries in particular districts possess good plans and sections of their workings, and an inspection of such plans and sections affords a view of the system of ventilation and general mode of working adopted, this is far from being the case generally, and has been much regretted alike by the enlightened coalowners and by the public. The importance of correct plans and sections has been prominently pointed out, both by the Committee of the House of Commons of 1835, and in the report of the South Shields Committee of 1843; indeed, the necessity of them is sufficiently obvious.

Should the suggestion of a system of judicious inspection be considered worthy of consideration, the ready access to proper plans and sections of collieries, brought up to given times, would necessarily form a part of any general system of regulations. If correct (and power to ascertain that they were so would be essential), they would at once disclose the system of working and ventilation adopted, and, with information respecting the police regulations, and an account of the kind of lights employed, would at once afford a general view of the mode of conducting any particular colliery, and of the adjustment of the workings to conditions.

It being considered that safety lamps, properly used, do effect much security in the working of coal, and that in so many cases explosions do take place when they are not employed, it has often been suggested that the Legislature should compel the general use of safety lamps in coal mines. But, on the other hand, there are many collieries in which fire-damp never appears, and it would justly be considered a hardship in such cases to compel a precaution altogether unnecessary.

We would suggest that it could not be considered unjust for the Legislature to compel the use of safety lamps in all fiery collieries; and, in the present state of the law of property, it might even be prudent to assume that all collieries in districts where explosions have been frequent are fiery, putting the *onus probandi* that they are not upon the owners of such collieries. If proved to the satisfaction of the inspectors that no reasonable danger was to be apprehended in their collieries, license might be given for them to work with naked candles, this license ceasing at short periods, but being renewable on ascertaining that the conditions of the mine had not altered.

Careful investigations into the causes of explosions in collieries, only part of which arrest public attention by their magnitude, appear to have led to the very general conclusion that the condition of our collieries is most unequal. While in some localities there is so little to improve that it becomes subject of regret that such examples should not more generally be followed, in others it becomes a matter of surprise how the works can be permitted to remain in so defective a state, seeing that the owners themselves suffer much loss thereby. Under such a state of things, and considering the number of valuable lives annually lost by colliery explosions, the continued risk to which so many are daily exposed, the national injury sustained by the imprudent and careless mode of extracting coal in many localities—one often felt oppressively also by the parties engaged in colliery speculations—and that the workings for coal must be adjusted to local conditions, we are led to consider that these evils might be at least mitigated by the careful and judicious inspection of convenient districts by competent persons, the necessary funds to be raised from such districts by a very slight impost, not even exceeding one farthing on each ton of coal raised in it; and we believe that the cause of humanity and the interests of the coalowners would be alike benefited by a well-considered legislative measure of this kind.

We have, &c.,
H. T. De La Beche.
Lyon Playfair.

THE HOUSES OF PARLIAMENT.

The following are portions of Mr. Barry's evidence before the Committee appointed to inquire into the progress of the Houses of Parliament:—

"The committee had an impression, from evidence given by you on a former occasion, that you would be willing to undertake to warm and ventilate the new House of Lords upon a system of your own?—I believe I so stated.

If you were to adopt a system of your own, would it render it impossible hereafter to revert to such a system as Dr. Reid has in a general way recommended or suggested?—Is it meant that that question should apply to the House of Lords exclusively, or to that and any other portions of the building?

To the House of Lords exclusively?—As the subject is altogether new to me, I could not at the present moment answer satisfactorily; but if your lordships would give me four-and-twenty hours to consider that point, I will then be prepared to give you a definite answer to the question.

Do you think that you could prepare the apartment for the Peers by the commencement of the session of 1847, if it were ventilated and warmed according to your own system, and without any interference with your system from any other quarter?—Until I have determined what that system shall be, it would be rather difficult for me to answer that question. With respect to the fixing of the joiners' work, as unfortunately a very large portion of the year, and the portion best adapted for fixing work of that description, has been suffered to elapse, I should be sorry to pledge myself that I would completely finish the House of Lords by the time mentioned, viz. the commencement of the next session; but all I can say is, that I will do every thing in my power to accomplish the object, and I trust that I should at least be able to bring the House into such a state as, if not completely finished, it might be occupied by your lordships.

The "session" is rather an indefinite word; do you mean by the 1st of February?—I understand the commencement of the session to mean the 1st of February.

You think you could get the House ready by the 1st of February?—I should not wish to pledge myself to have the House completely finished in all respects by that time; but I think I could finish it so completely that it might be occupied by your lordships.

You mean that every convenience for the sitting of the House might be supplied, although the more ornamental parts might not be finished?—Exactly.

Has any further advance been made in the arrangements of Dr. Reid since you were last examined before this committee?—Not that I am aware of.

Have you the slightest hope, from what has already transpired, and from what you are able to collect, that the work would be at all advanced by this time next year, unless some new arrangements were made with regard to the ventilation?—I must say that I have no hope whatever.

All the fittings are prepared?—They are, with the exception of portions of the throne, and they would be prepared during the time that the rest of the fittings were being fixed.

In making any arrangement for the ventilation, you do not conceive it will be necessary to destroy any part of that which has already been prepared in connection with the arrangements suggested by Dr. Reid?—I do not think it would be necessary to destroy any part; it would be necessary, probably, to modify some of the arrangements, in order to make them available to my own system, if I may so call it.

In the arrangement that you would contemplate for warming, you would not have to alter the ceiling, or any thing that has been done there?—Not at all.

Is the putting up of the ceiling a very expensive work?—The putting up of the fittings is a very expensive and rather tedious work; the work is of an unusual description, and will require the greatest possible care in fixing.

Are you in such a state that you could proceed immediately towards the completion of the House if you received the necessary authority?—Yes; I am quite prepared to do so.

Will you describe the state of forwardness of the building adjoining the House, including the lobbies?—The Victoria Hall, which is the apartment immediately adjoining the throne end of the House, is covered in, and the ceiling is nearly fixed. I think it possible to make that room available as well as the House, although the fittings which are to be placed in it might not be completed. The public lobby is also roofed in, and the ceiling is completed, and if it were necessary, that portion of the building also might, I think, be got ready for use. The finishings of the corridors adjoining the House on each side are entirely prepared, and I think, if the time is sufficient for fixing the work, which is very minute and elaborate, there is no reason why the corridors should not also be made available for occupation with the House.

What is the state of the royal gallery?—The roof of the royal gallery is on, and a commencement is made with the fixing of the ceiling.

What is the state of the Queen's robing room?—The roof is over the Queen's robing room, and the brick arches forming the ceiling are turned, but none of the fittings are commenced.

In what state is the staircase from the royal entrance?—That is in a very forward state. All the stonework is completed, or nearly so, with the exception of the steps.

Have you sufficiently digested your plan for the ventilation to be able to state in what manner you propose to introduce the air into the House and the lobbies?—No, I have not, because my attention has not been directed to that part of the subject.

But you have stated that you would be prepared to undertake the ventilation and warming of the new Houses, and to complete the arrangements before the meeting of next session?—Yes.

Without tying you down to a day, you can have no objection to the committee reporting that you propose to ventilate and warm the apartments upon your own responsibility?—None whatever.

And that that is not the portion of the work from which you contemplate any delay in preparing the House for next session?—Not at all.

If Dr. Reid's plan was abandoned, as it respects the House of Lords, will the central tower still be necessary?—If Dr. Reid's system, or any part of it, is adhered to in other parts of the building, it will certainly be necessary, according to the arrangements made, to have the central tower.

But not otherwise?—Not absolutely necessary, except for Dr. Reid's purposes.

With respect to the central tower being abandoned for the purposes of ventilation, might not that tower be made available for other public purposes?—I think it might.

Do not you think that even in the event of abandoning Dr. Reid's scheme it would be a great loss to the design if the central tower were given up?—I think it would be very desirable to retain the central tower; but I do not mean by that to say that it would be desirable to retain the same height or form of tower as would be required by Dr. Reid for his ventilating purposes. I think the central tower would be a great ornament to the building; but I am not of opinion that it is necessary to carry it to the height that Dr. Reid requires in order to obtain the effect that I should desire.

The central tower, such as contemplated by Dr. Reid, would be of a lower height than the Victoria tower?—I am hardly prepared to answer that question, because I am not aware that Dr. Reid has yet made up his mind as to the height of it. When I have spoken to him on the subject, he has said, "I should like to have it as high as possible; the higher the better; higher than Saint Paul's," and so forth.

What is the proposed height of the Victoria tower?—About 342 feet.

The following are the answers of Mr. Philip Hardwicke, Mr. George Stephenson, and Professor Graham, to questions submitted to them by the Chief Commissioner of Woods in regard to the warming and ventilation of the New Houses of Parliament.

I. To call upon Dr. Reid to lay before them the details of the system of warming and ventilation, as intended to be applied to the New Houses of Parliament?—In consequence of the instruction numbered I., we called upon Dr. Reid to lay before us the details of his system of warming and ventilation, as intended to be applied to the New Houses of Parliament. He has laid before us his general principles on warming and ventilation, the details only to a limited extent, but sufficient to enable us to form an opinion on the subject.

II. To consider and to report how far it is practicable, and if practicable whether it would be advisable, that such system should be extended to the whole building, including the subordinate offices and private residences contained therein; or whether the application of the system should be restricted to such portion as comprises the two Houses of Parliament, their corridors, libraries, kitchens, and refreshment rooms, or to a still more limited portion?—Agreeably to the instruction numbered II. we have considered Dr. Reid's system as he has explained it to us. It consists of of one general scheme for the warming and ventilation of the whole of this extensive building, bringing in the atmospheric air from a considerable altitude at the Victoria and clock towers at the two extremities of the building, carrying off all vitiated and impure air by a set of channels, both conveyed to a central tower proposed to be of greater elevation than the towers already mentioned. Although the scheme may be practicable, we are of opinion that it is too much complicated in its details and ultimate management to render such a system advisable to be applied to the whole building, including all subordinate offices and private residences contained therein, and that the application of the system considerably modified should be restricted to such portions as comprise the New Houses of Parliament, their corridors, libraries, kitchens, and refreshment rooms.

III. To consider and to report whether there would be advantage in applying the system, as far as its application should be deemed advisable, to different divisions of the building separately and independently of each other?—In reference to the third instruction, we are of opinion that there would be advantage in applying the system modified to two divisions of the building—viz., to each House of Parliament, and the various rooms and corridors belonging to it, and separately and independently of each other. We are further of opinion that it would be unnecessary to apply the system to the committee rooms, as we consider they are capable of being warmed and ventilated in a more simple manner. That whatever warming and ventilation may be required to the Speaker's residence and the other private residences should be effected separately and independently of any other parts of the building, and from each other.

IV. To ascertain and to report how far Dr. Reid's system of warming and ventilation is compatible or can be made compatible with rendering the buildings or the portions thereof to which it is applied fire-proof?—We have not been able to consider the fourth question so much in detail as could be desired to enable us to express a decided opinion upon it; but we have a strong impression that the system of warming and ventilation, as proposed by Dr. Reid (if carried out in conformity with his plan) cannot be made compatible with rendering many portions of the building fire-proof.

V. And, according to the opinions which may be formed of the points above mentioned, to ascertain and to report how far such plans and information in regard to the building have been supplied to Dr. Reid as are sufficient to enable him to furnish to the architect corresponding plans and information, in regard to ventilation, or if further information should be considered requisite for either party, to what extent and in what manner it should be furnished?—With respect to the fifth point it appears to us that Dr. Reid has had access to or been furnished with a great many plans and sections of the building, and has received sufficient assistance to enable him to apply his plans for warming and ventilation to the building in progress.

Philip Hardwicke.
Geo. Stephenson.
Thomas Graham.

South Audley-street, 25th June.

LIVERPOOL TOWN-HALL DECORATIONS.

The *Liverpool Mail* praises the deceptions employed in the decoration of the staircase of the Liverpool Town Hall in the following terms:—By some process, the invention of Mr. Ingram, decorative artist, of Birmingham and London, who is now, with about twenty of his own workmen, carrying on this work, the walls, which are of the usual description, and pillars, are made to represent the finest polished marble, and are susceptible of receiving a polish of great brilliancy. The walls are enamelled in imitation of Sienna marble, and the columns are finished in Jasper marble. So perfect is the work, that the best judges acknowledge the imitation to be perfect, and, *to the untutored eye, the deception, we are sure, would be complete.* On the window cases and framing are painted the arabesques from the Vatican—the arabesque style being strictly observed, nothing which has life being introduced. The door cases will be finished in imitation of statuary marble, highly polished, and the Jasper pillars stand out in bold relief from the Sienna and statuary marble. The whole of the ornaments in the door cases and under the dome, the friezes, cornices, &c., are richly etched with gold. This enamelled style differs much from that of scagliola, inasmuch as that great transparency and sparry character, peculiar to marble, can be produced."

WORKING STOCK OF EXISTING RAILWAYS.

The following is an abstract of the Returns made to the Railway Department of the Board of Trade, in pursuance of an order of the House of Lords, of the "Working stock (engines, carriages, and wagons) belonging to Railway Companies at present in operation":—

Name of Railway.	Engines.	Passenger Carriages.	Luggage Vans and Trucks.
Arbroath and Forfar	5	12	110
Birmingham and Gloucester	40	46	586
Bristol and Gloucester	11	20	213
Chester and Birkenhead	10	60	36
Dublin and Drogheda	15	69	105
Dundee and Newtyle	7*	9	138
Durham and Sunderland	13†	23	28
Dunfermline and Charlestown ..	Horses	2	189
Eastern Counties	66	204	1142
Edinburgh and Dalkeith	Horses	28	104
Edinburgh, Leith, and Granton ..	Horses	8	
Glasgow, Paisley, Kilmarnock, and Ayr ..	31	133	1334
Grand Junction, including Liverpool and Manchester, and Bolton and Leigh ..	128	343	1978
Gravesend and Rochester	4	16	6
Great North of England	37	46	717
Great Western..	127	232	919
Hartlepool Dock and Railway ..	5	8	6
Hayle	7‡	6	119
Hull and Selby	17	45	238
Lancaster and Preston Junction ..	6	37	36
Leicester and Swannington	8	4	13
Llannelly and Llandillo	4	2	454
London and Blackwall	2†	47	9
London and Brighton	44	163	423
London and Croydon	8	56	89
London and South-Western	47	212	508
Manchester and Birmingham.. ..	27	100	961
Manchester, Bolton, and Bury Canal Navigation and Railway	12	52	228
Maryport and Carlisle (including Whitehaven junction)	8	16	135
Midland	109	251	1842
Newcastle and Darlington	37	81	2515
Newcastle-upon-Tyne and North Shields ..	5	28	124
Newcastle-upon-Tyne and Carlisle ..	26	67	653
Newtyle and Coupar Angus	1	2	48
Norfolk	18	50	497
North Union	19	49	54
Pontop and South Shields	13	§	2649
Preston and Wyre	8	40	108
St. Helen's Canal and Railway ..	9		20
Sheffield, Ashton-under-Lyne, and Manchester	25	105	469
Stockton and Hartlepool, and Clarence ..	19	23	67
South Eastern	90	409	881
Taff Vale	12	23	328
Ulster	11	34	102
Wishaw and Coltness	11	10	1016
York and North Midland	48	109	1059

* 3 are stationary engines.
† All are stationary engines.
‡ 2 are stationary engines.
§ Passenger carriages provided by the Newcastle and Darlington Company.

AMERICAN PATENTS.

Granted in April, 1845, reported in the American Franklin Journal.

For "*an Improvement in carriage wheels.*" Ellphalet S. Scripture, New York City.

The object of this improvement is to arrange the spokes and hub in such manner as to afford a ready means of tightening the wheel when the spokes become loose by shrinking, which is effected by inclining the spokes either way from the plane of the wheel to form what is termed a double dished wheel, one half of the spokes being inserted in a permanent hub or cheek piece, and the other half in a movable hub, or cheek piece, which slides on the pipe box, so that by means of a nut the moveable hub can be forced with its spokes towards the other, and thus tighten the spokes.

For "*an Improvement in the connecting rods for connecting the crank pins of three or more driving wheels of locomotives.*" Holmes Hinckley, Boston, Mass.

The object of this improvement is to connect three, four, or more, driving wheels with a single connecting rod, and permit those between the two end ones to have a vertical and lateral play, which is effected by having the crank pins of the intermediate wheels work in boxes that slide vertically in the connecting rods, the said crank pins being made of sufficient length to give end play to the axles.

Claim—"I claim making the boxes to slide vertically in the connecting rod, in combination with extending or lengthening the crank pins of the wheels beyond the said boxes, so as to slide through them in the direction of their axes, as set forth; the whole being for the purpose of converting all of the several wheels of the engine into drivers, as described.

For "*Improvements in the auxiliary steam engine for supplying steam boilers with water.*" John Cochrane, Baltimore, Md.

The patentee says, "The intention of an auxiliary supply engine is not only to supply water to a boiler, but to preserve the same at a uniform height therein, without its being affected by any irregularity in the consumption or evaporation of that fluid; said auxiliary engine stopping and starting, and working quickly or slowly, as the demands of the boiler may require. Under the arrangement that I prefer, the admission of steam to the auxiliary engine is governed by a float and balanced valves, placed in a chamber outside the boiler, but communicating therewith by two branches, one above and the other below the water line; so that the water may have the same level both in the chamber and boiler. The float is furnished with a tubular stem at bottom, opening into it, for the purpose of carrying off any leakage; this stem passes out through a stuffing-box in the lower part of the chamber, the arrangement of this part being substantially the same with that represented and described in the specification and drawings accompanying letters patent of the United States, granted to me on the 13th day of July, 1844, for regulating the supply of water in steam boilers. The float, however, may be otherwise arranged and modified, the only requisite being that its action on the steam valve should be governed by the height of water in the boiler.

"It is not pretended that an auxiliary engine for the supplying of water to steam boilers is in itself new, such engines having been heretofore employed for that purpose; but I have, as I believe, succeeded in so constructing and arranging the parts of such an engine as to obviate the main difficulties heretofore encountered in the attempts to employ them."

Claim.—"Having thus fully described the nature of my improvements in the auxiliary supply engine, what I claim therein as new and desire to secure by letters patent, is, first, the manner herein described of completing the stroke, or traversing motion, of the valve, by the commencing return stroke of the piston operating on the spring arms, substantially in the manner and for the purpose herein set forth.

"I likewise claim the manner of regulating the stroke of the water pump, by adjusting the same by means of a valve, or cock, as set forth, so that a smaller and regulated quantity of steam shall be admitted to the lifting, than is admitted to the forcing, side of the piston, as described."

For "*an improved method of supplying water to steam boilers by means of an auxiliary steam engine.*" Isaac N. Coffin, Washington, D. C.

Claim.—"What I claim as new, and desire to secure by letters patent, is the combination of the float with the valve, steam engine, and supply pumps, substantially as herein described, so that the depression of the float, caused by a deficiency of water, shall open a valve, and that the steam which escapes through said opening shall drive an engine to operate the supply pumps."

For "*a hydrostatic power machine.*" John Gregg, Rochester, Monroe county, N. Y.

The patentee says,—"There are many situations in which the power of water can be obtained under a very considerable head which, from local causes, cannot be rendered available by means of water wheels without an expenditure of money greater than could be made with prudence; it is principally in such situations that it is intended to employ the machinery invented by me. To effect this object, I employ two cylindrical or other formed water receivers, into which receivers, water is alternately admitted under any desired head, and is made by its pressure to condense atmospheric air, which air, so condensed, is to be conveyed by tubes to a cylinder furnished with a piston, valves, and other appurtenances, similar to those usually employed in a steam cylinder; the air being, in fact, substituted for steam in such manner as that an ordinary steam cylinder* will not require any alteration to adapt it to use by means of condensed air."

For "*Improvements in the steam engine.*" Ralph Pomeroy, Belleville, Essex county, N. J.

Within the cylinder of this engine there are four pistons, the two end ones being connected together and operating one crank; and of the other two, each operates a separate crank; and the three cranks being on the same shaft and dividing the circle into three equal parts. All the piston rods, except the last, are hollow, and pass through each other, and the steam is to be admitted alternately to the different pistons, and so cut off, that whilst it is expanding in one division, another division is receiving the steam directly from the boiler, but the manner of operating and arranging the valves for this purpose is not described or represented.

Claim—"What I claim as my invention and desire to secure by letters patent, is combining four pistons, constructed and arranged substantially in the manner set forth, in one cylinder; said pistons being connected with three cranks placed at about an angle of 120° from each other, all as herein described."

* Why not admit the water at once into the cylinder?—Ed.

REGISTER OF NEW PATENTS.

If additional information be required respecting any patent, it may be obtained at the office of this Journal.

MOULDING IRON.

William Mushet and Robert Mushet, iron-founders, of Dalkeith, Scotland, for "*Improvements in moulding iron.*" Granted Dec. 10, 1845; Enrolled June 10, 1846.

This invention consists in the application of stampers and rollers or other suitable apparatus for pressing the sand into the boxes instead of performing such operation by hand as heretofore. In carrying out this invention, the patentees propose to employ a machine having one or more stampers, or rammers, worked by means of eccentric or other convenient means, or the same may be effected by a roller or rollers in the following manner: that is to say, the sand after being put into the lower box, is placed upon a carriage and passed under the machine, for the purpose of compressing it into the box, the mould being inserted and suitable sand employed to form the parting; the top box is then put upon the lower one and filled with sand in the usual manner, when it is again subjected to this improved mode of ramming, after which the mould is finished in the ordinary manner. The patentees state that the moulding of railway chairs and other similar articles, when a great number of the same sort are required, will be greatly facilitated by the process above described.

STEAM ENGINE IMPROVEMENTS.

William M'Naught, of Glasgow, Scotland, engineer, for "*certain improvements in steam engines.*"—Granted December 10, 1845; Enrolled June 10, 1846.

This invention, which relates to certain improvements in steam engines, consists in the application of what the inventor terms a non-condensing cylinder, in addition to the present cylinder in beam engines, which present cylinder may be supposed to be the condensing cylinder. In carrying out these improvements, the patentee proposes to have a second steam cylinder placed between the centre of the beam and the connecting rod, the piston rod of such cylinder being attached to the beam by means of links, and to that part thereof about midway between the connecting rod and beam gudgeons. This auxiliary cylinder is provided with a valve of the ordinary construction, and worked by a rod, one end of which is attached to a lever keyed upon the weigh shaft of the ordinary cylinder, the other end being attached to a lever on the weigh shaft of the auxiliary cylinder, so that the valves of both cylinders are worked by one eccentric. The action of the engine is as follows: that is to say, the steam from the boiler is first admitted into the auxiliary cylinder, and having acted upon the piston so as to force the same from the top of the cylinder to the bottom, it passes through the eduction pipe into the ordinary cylinder at the opposite end of the beam, and into such cylinder at the upper part thereof, so as to force the piston down after performing the stroke; the steam passes through the eduction pipe into the condenser, which is of the ordinary construction. So that the steam from this additional or auxiliary cylinder, after having performed a stroke—say the up stroke—passes from the underside of the piston of that cylinder to the underside of the piston of the ordinary cylinder, which latter, it will be observed, is at the bottom of its cylinder when the other is at the top, so that the inventor works with high pressure steam in one cylinder and low pressure in the other, from which latter the steam passes into the condenser.

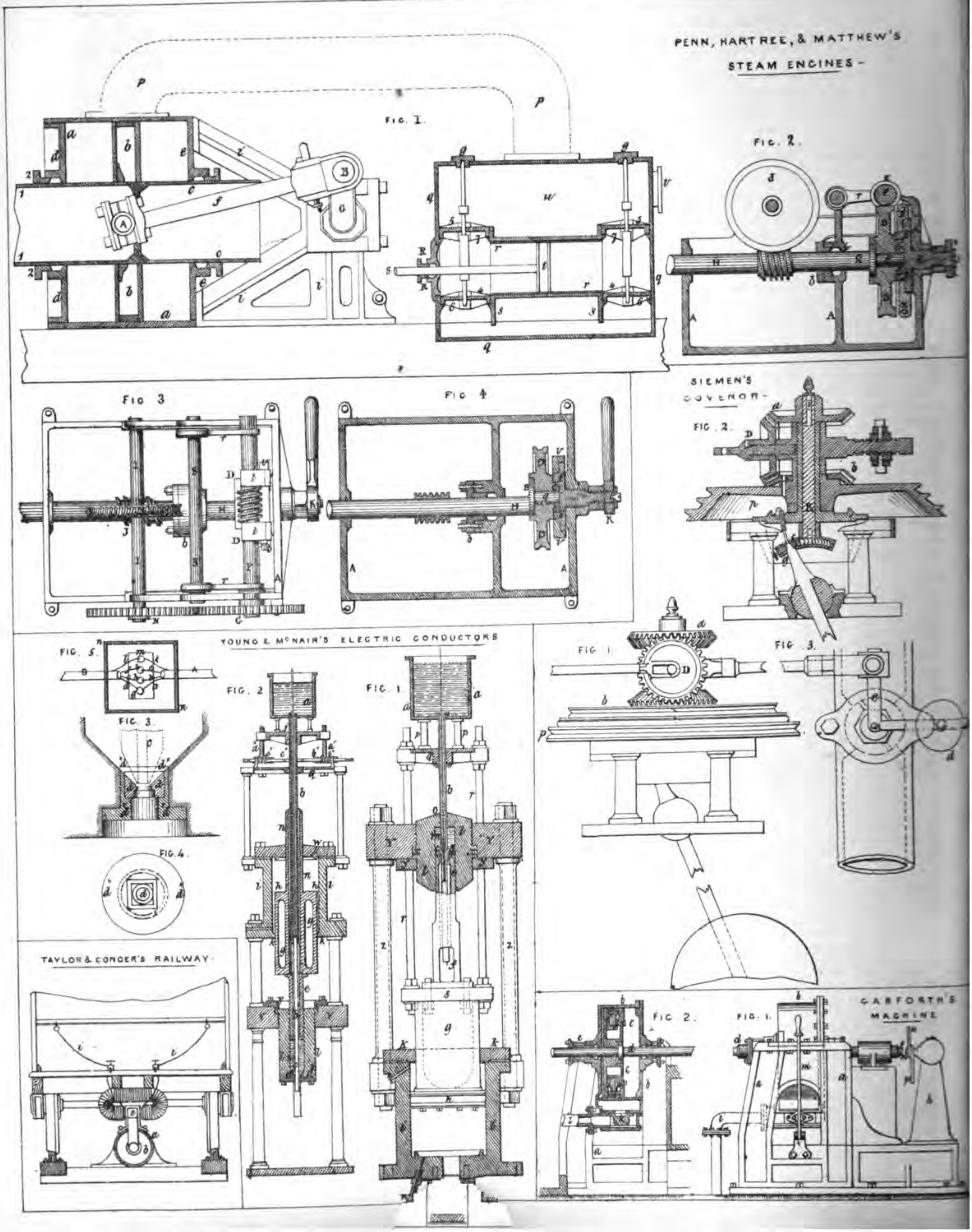
The specification shows a mode of applying the invention to marine steam engines, in which case there is a cylinder placed at each end of the beam, one of which, that is, the high pressure cylinder, being somewhat smaller in diameter than the other; by this means the power is said to be more equally distributed than in engines having but one cylinder.

RAILWAY CARRIAGE WHEELS.

Joseph Romnald Bozek, of Cheapside, mechanic, for "*Improvements in the construction and application of railway carriage wheels.*"—Granted January 6; Enrolled June 24, 1846.

The improvements relate to the application of the flange of railway wheels on the outside instead of on the inside of the wheel.

NEW PATENTS



PENN, HARTREE, & MATTHEW'S
STEAM ENGINES -
FIG. 1.
FIG. 2.
FIG 3
FIG 4
SIEMEN'S
GOVENOR -
FIG. 2.
FIG. 1.
FIG. 3.
YOUNG & McNAIR'S ELECTRIC CONDUCTORS
FIG. 5.
FIG. 3.
FIG. 4.
FIG. 2
FIG. 1.
TAYLOR & CONDER'S RAILWAY
FIG. 2.
FIG. 1.
GARFORTH'S
MACHINE

GLASS TILES.

JOHN RUSSELL, of Edinburgh, accountant, for "*Manufacture of glass tiles.*"—Granted December 30, 1845; Enrolled June 30, 1846.

This invention relates to making tiles out of sheets or pieces of glass; the pieces have two of their opposite sides turned up perpendicularly, from half an inch to an inch, to form flanges, and made in such a manner that the plane or flat part of the glass shall be wider at the upper end of the tile than the lower end, so as to allow the lower end of one tile to lap and fit into the top of another between the two flanges. These tiles, the inventor states, may be formed of any shape, suitable for hips, valleys, domes, or arcades, and either of stained, coloured, or opaque glass. The tiles when used are laid on laths nailed on to the rafters, in the usual manner, and the apertures between the flanges are to be filled up with putty or any other suitable cement, and covered over with a hollow bead of metal or glass, or a thin slip of metal may be fastened to the rafters and passed up between each tile and then turned over the flanges on the top.

The patentee states that he does not claim the mode of shaping or manufacturing the glass, but only for the form or shape of the glass and for the purposes of roofing, as above described.

ATMOSPHERIC RAILWAYS.

JOHN ROBERT JOHNSON, of Alfred-place, Blackfriars, in the county of Surrey, chemist, for "*Improvements in the materials employed in constructing and working atmospheric railways.*"—Granted December 6, 1845; Enrolled June 6, 1846.

This invention relates, first, to a new composition for sealing the longitudinal valves of atmospheric railway tubes. It is made by adding to various mixtures of resinous, oily, and bituminous substances, dry clay, ochre, and chalk, in powder, as much as will make the composition of the proper consistency; the following mixture is preferred and found to succeed: 1 part palm oil, 2 parts brown resin, and 4 parts china clay, in fine powder. Insoluble soaps, prepared by a combination of fat and an oxide or earth with oily or resinous substances, may answer the same purpose.

The second improvement is a composition for lubricating the interior of the traction tubes, made by mixing with fat or oil, and resin or pitch, a quantity of earthy matter, as before described; the following proportions are recommended: 7 parts resin, 4 parts stearine, 4 parts tallow, and 12 parts clay.

The third improvement is for making fabrics impervious to air and moisture with elastic varnish, for the purpose of using them instead of leather for the longitudinal valves. The fabric may be made either of cotton, flax, hemp, or wool, in the form of a belt, of the breadth and thickness required. The varnish must be such that oils or fats will not act upon it when dry, and it must possess sufficient elasticity to bear the bending resulting from its use; linseed or nut-oil is preferred, particularly boiled linseed oil, which is made to penetrate the fabric by heating the oil to 250°, and immersing it therein until the air and vapour is expelled from the interstices of the fabric. The fabric is then passed between a pair of iron rollers, to squeeze out the superfluous oil, and dried in a warm room, and afterwards again passed through oil heated to 200°, and also between the rollers, and dried. The operations are repeated until the interstices are filled by the successive coats of varnish and the fibres cemented together into one mass. To remove the inequalities, if any, on the surface, pumice stone must be used, after which a finishing coat of varnish is to be applied.

The fourth and last improvement is for constructing the traction tubes of materials not before used for that purpose, such as calcareous cement, Keene's cement, Roman cement, and the like, which can be cast in the form desired, and do not require burning. The cement may be mixed with sand or fine gravel and rammed into moulds of the form required. The patentee prefers to form the pipes by the aid of an apparatus made with a cylindrical case and a hollow core for forming the inside of the pipe. When the tubes are dry and seasoned they are rendered impervious to air and moisture, by causing the cement to absorb coal-tar, which has had its more volatile portions separated by distillation.

STEAM ENGINES AND PROPELLERS.

JOHN PENN, of Greenwich, engineer and manufacturer of steam engines, WILLIAM HARTREE, the younger, and JOHN MATTHEW, of Greenwich, engineers, for "*the invention of certain improvements in steam engines and machinery for propelling vessels, which improvements are also applicable for other purposes.*"—Granted December 25, 1845; Enrolled June 25, 1846.—Reported in the *Patent Journal.* (*See Engraving, Plate* XIII.)

These improvements in steam engines relate to a certain mode heretofore invented, of making the piston rod of steam engines of enlarged size, and hollow, like a tube, to admit a long connecting rod to be received within the hollow of the piston rod, for transmitting the force and motion of the piston to the revolving crank on the axis, which is to be turned round by the force of the steam engine, like the direct acting steam engines, the said connecting rod being jointed to the piston at that end of the rod which is furthest within the said hollow of the piston rod (and which for distinction may be termed its inner end), and the other (which may be termed the outer end, because that end extends out from the said hollow beyond the hollow end of the piston rod) being jointed upon the crank pin of the revolving crank, so as to operate by direct action for turning the crank and axis thereof round. The said hollow within the piston rod is sufficiently wide for permitting the vibration of the connecting rod, without touching the inside of the hollow, so that the connecting rod being moved round with continuous onward motion in the circumference described by the crank pin, the joint at the inner end of the connecting rod will move with alternating motion in a line which is central with the line of the piston rod, the said joint being guided in the said line by the sliding motion of the hollow piston rod, through its stuffing box in the cylinder covers, as the motion of the crank pin in the circumference of its orbit will occasion a very considerable extent of vibration of the connecting rod within the hollow of the piston rod, which is of so large size externally, in order to have sufficient hollow to allow its vibration without touching. The large size of the hollow piston rod deducts materially from the surface of the piston against which the steam is to act for impelling the piston in that direction which will move the large hollow piston rod (through its stuffing boxes in the cylinder covers) into the interior of the cylinder; consequently the piston will be impelled with less force than if the rod were small, or of proper size to such piston. But, on the other hand, steam will operate against the whole area of the piston, without any such deduction therefrom, when steam operates for impelling the piston in a contrary direction to that already said, or in that direction which will move the large hollow piston rod (through its stuffing box), out of the interior of the cylinder. Hence, the piston of a direct-acting steam engine, with large hollow piston rod as aforesaid, will move by the steam with more velocity in one direction during one half of the stroke, than in a contrary direction during the other half of the stroke. And to avoid any unnecessary size of the hollow piston rod, the same (instead of being of cylindrical form and circumference in its transverse section), has been made oblong in its transverse section, having two flat sides and two semicircular ends, so that the lengthway or oblong should allow as much room within the hollow of the connecting rod as required for the performing of its vibrations, but in breadthway the oblong hollow being no wider between the two flat sides than necessary for admitting the connecting rod to move freely. The stuffing box in the cylinder-cover was adapted to the oblong form of the said hollow piston rod. In direct-acting steam engines, with such oblong flattened form of hollow piston rod, have been called trunk engines, and were subject of patent granted to Francis Humphreys, for England, 28th March, 1835.* Our improvement in steam engines of the aforesaid description, consists in extending the aforesaid hollow piston rod or trunk each way from the piston, instead of merely on one side as heretofore. And with that improvement, the surface against which steam will operate for impelling the piston, will be the same when impelled in one direction as the other. Also, the guidance of the piston in its alternating rectilinear motion within the cylinder, will be rendered more complete in consequence of the said prolonged hollow piston rod passing through the stuffing boxes at both ends of the cylinder. Also, the joint at the inner end of the long link or connecting rod, is rendered more accessible than heretofore. Fig. 1, is a horizontal section of an engine constructed according to this part of our improvements; *a a*, is the steam cylinder; *b b* the steam piston fitted into the cylinder, and moving up and down therein; *c c*, the hollow piston rod or trunk, fastened to the piston, and moving therewith; *d d*, the end of the cylinder; and E E, the cylinder cover, having the stuffing box, *e e*, at the centre part of it for hollow piston rod, *c c*, to pass through; *f* is the long link or connecting rod, jointed at its inner end upon a pin, A, at the centre of the piston, and jointed at its outer end upon the crank pin, B, of the revolving end of the crank, G, which is on the main revolving axis of the steam engine; *i i*, is the frame-work for sustaining the said axis. The hollow piston rod may be either of cylindrical or oblong form, as aforesaid, but must be truly prismatic. In the motion of the engine, the centre of the joint-pin, A, at the inner end of the connecting rod, will move along the cylinder with an alternating rectilinear motion, whilst the centre of the crank pin, B, at the outer end of the said rod, *f*, is moved onwards around, in the circle described by the crank pin with a continuous rotary motion, and during such motion the connecting rod *f* will require to vibrate from the direction of the central line of cylinder to the extent of the internal diameter of the piston rod, with alternate deviation on opposite sides. The hollow within the hollow piston rod *c c*, is sufficiently large to permit of such extent of vibration of connecting rod *f* on either side. Thus far this engine is the same as other trunk engines, or hollow piston rod engines; but fig. 1 show the hollow piston rod *c*, *c* to be prolonged at 1, 1, from opposite side of the piston *b*, *b* to that side thereof from which the aforesaid part *c*, *c* proceeds; the prolonged part 1, 1 passing through, and being fitted with a stuffing box 2, 2, at the centre part of end, *d*, *d*, of cylinder, and the part 1, 1 being a continuation of the part *c*, *c*, which, together with the said part 1, 1, forms a long hollow piston rod, *c*, *c*, having piston *b*, *b* fastened to it at or near the middle of such rod, and the said long hollow rod *c*, *c*, being guided by both stuffing boxes at *e*, *e* and 2, 2; the piston *b* is thereby securely retained in a proper position at the centre of the cylinder when moving with its alternating motion therein, without any undue rubbing with more force at one side than the other of the inside of the cylinder; and the said long hollow rod *c*, *c* being open at the end of the prolonged part 1, 1, the joint of the inner end of the connecting rod *f* upon

* See C. E. and A. Journal, vol. 3, 1840, page 142.

the pin A can be got at for screwing up or tightening brasses of such joint when the engine is stopped. Fig. 1 is supposed to be in every other respect exactly like other direct acting engines, which, being well known, need not be described. The air pump may be worked by means of another short crank or an eccentric upon the main revolving axis. Such an engine may have the fly wheel on its main axis, and may be applied for actuating any machinery requiring a continuous rotary motion; or may be applied in steam vessels, in which case the main axis would be prolonged each way across the vessel to serve as the axis for wheels on each side of midship line of vessel with the main axis of both engines in the same horizontal line across the vessel, the air pump or pumps being amidship in a space left for the purpose between the two engines, and the air pump or pumps may be worked by a short crank or cranks, or eccentric or eccentrics on the main axis, all which being the same as in direct acting engines need not further be described; and in consequence of the effectual guidance of the piston during its motion in the cylinder, which results from the long hollow piston rod passing through stuffing boxes in both ends of the cylinder as above described, such an engine is well qualified for working with the centre line of the cylinder in a horizontal position, as in fig. 1, because the weight of the piston and its hollow piston rod is effectually sustained by the fitting of long hollow piston rods into and through the stuffing boxes at both ends of the cylinder, and therefore that weight will not cause the circumference of the piston to rest with any more force at the lowest part of the internal surface of the cylinder than at the upper or other part of that internal surface. Engines of this description are well adapted for steam vessels having revolving propellers at the stern under water, or nearly so, operating in water by an oblique or spiral screw, or windmill-shaped propeller, that require their axis to be low down within the vessel, and to be turned round with a rapid motion.

Several different engines are given in the drawings attached to the specification,—some vertical, others with the connecting rod projecting from the lower part of the hollow piston rod, with the cylinder at right angles to each other, and attached to the same crank, or the end of the propeller shaft.

Another part of the said improvements in steam engines relates to the air pump, or rather to the valves of the air pump in cases where the air pump is placed in a central line in a horizontal position, and is double acting, so as to draw water and air from condensers, when the piston of the air pump is moved either backwards or forwards in its horizontal barrel; an air pump, disposed in a horizontal position, double acting, as aforesaid, must have four valves and a solid piston; such air pumps have been proposed, and are not new, but, according to this part of the improvements, those valves, and the seats to which they fit, are so disposed with respect to the barrel of the pump, as to be able to be removed with ease, and spare valves and seats substituted when required. Fig. 1 contains a longitudinal section of a condenser and air pump, or a pair of condensers and air pumps, suitable for a steam engine or pair of steam engines, as already described. *q, q* is a metallic vessel, serving for condenser and hot water cistern. It may be divided with a vertical partition to divide its internal capacity into separate condensers for the two engines, or else may be two separate vessels, disposed side by side. In either case, the air-pump barrel, *r, r*, extends in a horizontal direction through the inside of each compartment (or of each condenser), with an opening into an end of the barrel, whereof one opening may be closed by a door, *q*, and the other by an air-pump cover, R, R, which has, as usual, a shifting box at the centre of it, for the rod, *s*, of an air-pump, to pass through the piston, *t*, of the air-pump, which is fastened on the rod *s*, is solid. The space left within vessel *q, q* around the extent of each horizontal air-pump barrel is further divided by a horizontal partition not shown in drawing, but it is nearly at the level of the upper part of each barrel, *r, r*, and so much of the upper space as is beneath the level of the horizontal partition is the actual capacity of the condenser for reception of steam that is to be condensed, and of the injection of cold water by which the condensation is to be effected. The eduction pipe, R, from the cylinder of the engine, joins by a side branch to that lower part or condenser; the space above the level of such horizontal portion is for the hot water cistern or hot well, into which the air-pump is to discharge the hot water, and air is extracted by it from the condenser, and the surplus of which hot water will pass away as usual by the overflow pipe, *v*.

The air-pump, being double-acting, requires to be constructed with four valves, two at each end of barrel, *r*, one of these valves being a foot-valve, for admitting water and air to pass from the condenser into the barrel, *r*, when the air-pump piston, *t*, is moving away from that end of barrel, *r*, at which such foot-valve is situate, and the other of the said two valves being a discharge valve for allowing air and water to pass out from barrel, *r*, into hot well, *w*, when air-pump piston, *t*, is moving towards that end of barrel, *r*, at which such discharge-valve is situated. This part of the improvements consists in disposing the said two valves, which are at the same end of the barrel of air-pump with said discharge-valve, exactly over foot-valve, so that the same upright spindle or guide rod will serve for both valves, and will also serve to keep seats for both valves in their respective places in the metal work at the end of pump-barrel, into which places the said valve-seats are accurately fitted. But when the guide-rod is withdrawn, then the valves become loose, and can be taken out for examination or repair, and the valve seats can also be removed out of their said places, if necessary, and other spare valve seats put in, and valves thereon. 6, and 4, are the lower or foot-valves, and 5, upper or discharge at each end of air-pump barrel, *r*, 6 and 7 being their respective valve seats, accurately fitted into recesses in the metal at end of barrel, *r*, those recesses being bored correctly circular, and slightly conical, so as to be correctly concentric with upright guide rod or spindle, 8, which passes through central hole of upper valve seat, 7, and into central hole of lower valve seat, 6, and has suitable shoulders formed upon it, for confining both seats, 6 and 7, down in their respective places, when rod 8 is forced and held down end-ways, by a cover, *g*, screwed down over a hole in upper part of hot water cistern, *q*, and which cistern bears on the upper end of the rod, 8, so as to press and hold the same down, and consequently fasten down the two valve seats, 6 and 7. Valves 4 and 5 have central holes through which the rod 8 passes, so as to allow the valves to fall and rise on the rod which guides them when so rising and falling, and the rod has suitable slip shoulders formed or fastened upon it, to limit the height to which the valves shall be allowed to rise. Valves 4 and 5 may be fitted to their seats, 6 and 7, with flat surfaces, or with conical fittings, when the door, *q*, or air-pump cover, R, is also corresponding with the door, in same end of hot water cistern, W, or one door on the top thereof, and likewise the Co 9; then the upright rod, 8, being withdrawn upwards through hole 9, will leave valves 4 and 5 loose, and at liberty to be removed through doors or openings aforesaid; and the valve seats, 6 and 7, may be also lifted out of their respective recesses into which they are fitted, with a sufficient tapering to be tight, but without any other fastening than by means of rod 8, as aforesaid. And the upper valve seat, 7, may be made so much larger than the lower valve seat, 6, as well as the upper one, through the hot water cistern, *w*, and its doors, as aforesaid. The upright spindle, 8, of two valves, 5 and 6, which are at the same end of the barrel, *r*, as its cover, R, is so much on one side of the central line of the barrel as to avoid any interference with the air pump rod, *s*. But *s* can be disconnected, and, together with the air pump present, can be withdrawn from the barrel, *r*, through the door, *q* or R, and the packing of piston *t*, can be performed at those doors. The recesses into which the valve seats for the foot valves, 6, 6, are lodged, should be continued downwards, as at *s, s*, near toward the bottom of the condenser, in order that water may be effectually drawn up from the lowest part of the condenser by the action of the pump; and as to our said improvements for propelling and other purposes, the same are, for the most part, applicable to vessels, with revolving screw propellers for diminishing friction and wearing which takes place at that extremity of the horizontal axis of the revolving propeller within the vessel, and which extremity, at the same time it is turning rapidly round, must press endways against some suitable fixed end bearing in the vessel, so as to transmit to that bearing the whole endway force of the propeller, by which the vessel is to be urged on through the water. This part of the improvements relates to such fixed end bearing or extremity of revolving axis, or any other end bearing for quick revolving axis in mill work or machinery of any kind, and consists in applying a flat circular disc of hardened steel or other hard metal, in a vertical plane at the proper place for receiving the flat end of the revolving axis, which end is also to be hardened steel, the said disc being larger in diameter than the said flat end, and being lodged in a cell at the central part of a toothed wheel, which is mounted at the end of a short horizontal axis, sustained in some suitably fixed socket, so as to be somewhat eccentric to the central line of the axis of the propeller, and the said toothed wheel being turned round by means of other wheel work, carries the steel disc slowly round with it in the same direction as the end of the axis of the propeller is, at the same time, revolving with a rapid motion; and owing to the said slow revolving motion of the disc being eccentric to the quick revolving motion of the end of the axis, fresh parts of the said surface of steel disc are continually brought opposite to, and in contact with, the same end, in order to avoid any tendency to wearing the rubbing surfaces into rings, as usually takes place, and also to introduce oil or water more effectually between the rubbing surfaces.

Figs. 2, 3, 4, show some of the improvements by way of example, but the details of construction there represented may be greatly varied. Fig. 2 is a longitudinal vertical section; fig. 3 a plan view, and fig. 4 a horizontal section taken at the propeller shaft. The box A, A, is to be securely fastened in the vessel, so that a spindle, H, will correspond with the direction of centre line of the axis of the propeller, the said spindle, H, being inserted and fastened into the end of the axis; but there is another suitable bearing not shown, which sustains the axis laterally on its intended place as it revolves. The spindle, H, passes through a hole in one end of the box, A, A, which has partition across it at A, through which the spindle, H, also passes in a stuffing box, *b*, the smaller compartment of which box contains the circular steel disc before mentioned, and filled with oil or water for keeping rubbing surfaces cool. This is better shown in fig. 2. *B* circular disc, and *D* is a toothed wheel into the cell, at the centre whereof the steel disc, *B*, is inlaid and fastened, so as to be held on vertical plane, and so as to be carried round with slow revolving motion of wheel, *D*, which is sustained by means of prominent central boss, *e, e*, on opposite side of it, to that side on which disc, *B*, is fastened, which boss, *e, e*, is received in, and fitted to, corresponding circular cell, *f, f*, which may for the present be considered as immoveably fixed, with its centre somewhat eccentric to centre line of spindle, H, as is apparent in fig. 3.

The toothed wheel *D*, is capable of turning round in said cell *f, f*, as though it were mounted on the end of the horizontal axis, and revolving therewith in a vertical plane, and carrying the disc *B*, round with it in such motion, and there may be a horizontal centre pin at *g*, in centre of the said cell *f, f*, fixed to or part thereof, and fitted into the central hole of the wheel *D*, around its prominent boss *e, e*, applies with close contact against the flat circular border around cell *f*, *f*, and by the aforesaid fittings and contact over a considerable diameter, the wheel D, and disc B, are securely sustained in their intended vertical planes, and qualified to bear the endway pressure of spindle H, notwithstanding the eccentricity thereof to wheel D, as shown in fig. 4. The aforesaid slow-revolving motion of the disc B, and wheel D, is given thereto by means of the endless screw E, on the cross axis F, which is turned round by spin-wheel G, on the end of it, that wheel receiving motion from another spin-wheel N, on the end of another cross axis I, whereon is another screw wheel J, which is turned by the endless screw *j*, on spindle H. The aforesaid wheel-work and screw-work will give a very slow revolving motion to wheel D, and the disc B, compared with the rapid revolving spindle H; but the proportions of the said wheels and screws may be varied, and the endless screws, E and *j* (or one or them), may be made with 2 or 3 spiral threads, in which case the revolving motion given to disc B will not be so slow. And if the parts are constituted according to the drawing, so that the cell *ff* is not immoveably fixed, the degrees of eccentricity can be varied at pleasure, and the motion quickened merely by turning the lever handle K, which is fastened on the extreme end of the axis *k* in figs. 3 and 4, which axis is part of the metal of the cell *ff*, but eccentric thereto, as shown in fig. 4.

It is easily seen that the said axis *k* is fitted into a socket, perforated through the end of the box A, and flat vertical surface of the said end around that socket, affords a flat bearing for the flat vertical surface at back of the cell, *ff*, around its axis *k*. The socket for the axis *k* is somewhat eccentric to central line of spindle H, as shown in fig. 4, and by the position of the parts there shown, the eccentricity of axis *k*, in respect to spindle H, concurs with the eccentricity of the cell *ff*, in respect to its said axis R, for giving the full degree of eccentricity for disc B, in respect to spindle H, that the disc B, and of the end of the spindle H, will permit, as is shown in fig. 4. But if the handle K, and axis R, with the cell *ff*, were to be turned half-way round from their said position, fig. 4, then the eccentricity of the axis R in respect to the spindle H; and those of the cell *ff*, in respect to the axis *k*, would counteract or neutralise each other, so as to give little or no eccentric motion to the disc B in respect to the spindle H. On the handle K being turned to any intermediate position between the aforesaid extremes would give any intermediate degree of eccentricity as may be preferred. The axis R should be made less tight into its socket, and to fasten them by screwing a nut on the end of the axis. The lever handle K should have some adequate means of holding it fast in any requisite position. And whereas the motion so given to cell *ff*, in turning it with its axis R by the lever handle K, as aforesaid, would derange the position of the wheel D in respect to the gearing of its teeth in spiral threads of endless screw E, the cross axis F of that screw; and if the spur wheel G must be allowed to to rise and fall in its bearings, but it will be retained at its proper distance from the cross axis I of the other spur wheel N by means of two levers *r r*, formed by bearings for the cross axis F, which bearings will rise or fall freely with it, but will always keep it horizontal. Also, the endless screw E is fitted upon its said cross axis F with feathers or keys, so as to be capable of sliding along that axis F, end-ways thereon, but so as to be compelled to go round therewith, and the place the endless screw will occupy in lengthening of its said cross axis F is regulated by two bearings *t t*, which are fitted on axis F, so as to include the screw between those bearings, *t t*, as projected from the collar, *v v*, fitted around the outer circumference of the cell *ff*, and are collars made on two halves united by screws *x x*; the said circumference is concentric with the interior of the cell *ff*, and consequently with the wheel D; wherefore when the cell *ff* is turned round by the lever K, the collar *v v*, by its projections *t t*, will cause the endless screw E to rise or fall, together with the axis F, or move sideways along that axis with such compound motion; *t* will always preserve proper contact of its spiral threads with the wheel D, for turning the same round, as aforesaid. Claim first: for improvements in steam engines, which have hollowed piston rods and connecting rods in the hollow thereof; of making such hollow piston rods extend both ways form the piston, and passing through stuffing boxes in both ends of cylinder, in order to obtain an equal surface of piston for receiving pressure of steam, and impelling piston in both directions in cylinder, up, down, back, and forwards, at same time obtaining secure guidance of the piston in such motion, in consequence of long hollow piston rod sliding through stuffing boxes at both ends of the cylinder, also rendering joint at inner end of connecting rod accessible within the hollow piston rod; but no claim is made to extending of piston rod each way from the piston, and guiding such long piston rod by passing through stuffing boxes in both ends of cylinder, when that is done for the mere purpose of the guidance of the piston in its motion within the cylinder; but claim is only made when the long piston rod, which is so guided, is hollow, for the purpose of receiving the connecting rod within the hollow, as before described. Secondly, in improvements in disposing the valves of horizontal double-acting air-pumps, with the lower or foot valve directing beneath the upper or discharge valve, and holding the valve seats for both those valves fast in the proper place, and also guiding the valves in their rising and falling motions by means of one forced upright spindle.

IMPROVEMENTS IN GOVERNORS OF STEAM ENGINES.

CHARLES WILLIAM SIEMENS, of Finsbury-square, Middlesex, engineer, for "*Improvements in steam engines and in regulating the power and velocity of machines for communicating power.*"—Granted December 24, 1845; Enrolled June 24, 1846. *See Engraving*, Plate XII,

The first part of this invention consists in some further improvements in the chronometric governor, a patent for which was granted to Mr. Joseph Woods, of Barge-yard Chambers, Bucklersbury, April 18th, 1844.

Figs. 1 and 2 represent the improved chronometric governor, which is generally applied to steam engines. The differential velocity between the engine and a revolving pendulum P is obtained by means of three bevil-wheels, A, B, and C. The wheel A is firmly connected with the arm or crank E of the pendulum by means of the upright shaft K, and revolves always in concert with the pendulum. The under wheel B is fixed to the pulley D, which is driven by the engine with its uncertain velocity and in contrary direction to the motion of A. Both these wheels move in gear with the third bevil-wheel C, which runs perfectly free on its axis, and is also permitted to travel round the perpendicular socket *d*. It is obvious that whenever A and B revolve in contrary directions, but with equal velocity, C will also revolve on its axis, but will not change its angular position, while any difference in velocity between A and B will cause C to follow the direction of the faster wheel, which will at once alter the supply of steam, the double arm *m* being attached to the throttle valve T by means of the lever and connecting rod *l*. To maintain the motion of the pendulum a constant power is required, resembling that of a falling weight in an ordinary clock. This power is given out by the weight *w*, which tends to pull the wheel C permanently to one side, and this strain being borne equally by the wheels A and B, causes A, and with it the pendulum P, to revolve, while B, which revolves in the contrary direction to A, is constantly engaged to lift W back again in its proper position. In practice, it has been found that the power requisite to maintain the action of the pendulum is much less than that required to effect the movement of the valve, and the inventor now adopts the principle of driving the pendulum with an excess of power, which shall be neutralised by a friction apparatus when not wanted, and shall be allowed to act freely when the governor requires its assistance to move the valve. This is effected as follows: R is a ring of cast iron or other proper material, against which a surface of steel or other material *g*, revolving with the pendulum, is pressed by its short lever, a spring *s* being placed between the point of the rod and the steel rubber, to let the pressure come on gradually. It is evident that whenever there is an excess of driving weight, which causes divergence in the arc of vibration, the surfaces of the steel rubber and of the fixed ring will be pressed in contact together with a force exactly sufficient to produce the required amount of friction necessary to counterbalance the excess; and so soon as the pendulum falls back towards a smaller arc of rotation it will relieve the friction apparatus, and permit an increased supply of power to overcome the resistances of the valve, &c. A second spiral spring *t* is laid in the groove of the arm F, behind the point of the pendulum, for the purpose of never allowing the latter to drop quite in its perpendicular position, and also to facilitate its starting with the engine.

There is also described another mode of obtaining the differential velocity between the pendulum and the engine and a governor of a more powerful description, which is calculated to move the gates of water-wheels or the expansion gear of large engines, but the general principle of these governors is the same as we have already described, and we therefore omit them.

The great advantages of the chronometric governor over Watts's Centrifugal governor, or others which have hitherto been proposed, are—that the engine must always keep pace with an "independent" pendulum, which will travel only with its proper velocity according to its perpendicular length —no matter whether the engine has to overcome the maximum of her load or none at all; and another principal advantage is, that the adjustment of the valve is done at the very instant when the equilibrium between the load and power of the engine is disturbed; there is no variation in speed visible, even if the whole amount of load of an engine is suddenly thrown off, an advance of about $\frac{1}{30}$th part of the revolution of the fly-wheel being sufficient to shut the throttle valve.

The patent has been applied to engines at the Steam Flour Mills of Mr. Carpenter, Shad Thames; at the saw mills of Mr. Rosling, Southwark-bridge, and Messrs. Ransome and May, Ipswich, and several other places.

ELECTRIC CONDUCTORS.

WILLIAM YOUNG, of Paisley, manufacturer and dyer, and ARCHIBALD MCNAIR, of the same town, merchant, for "*certain improvements in the construction and means of manufacturing apparatus for conducting electricity.*"—Granted August 4, 1845; Enrolled February 4, 1846. *(With Engravings, Plate XII.)*

This invention of improvements in the construction of apparatus for conducting electricity consists of a new and improved method of manufacturing electric conductors. The electric conductors are formed of one or more copper, tin, or other metallic or mixed metallic wires, which may be covered with cotton, woollen, or linen thread, in a manner similar to those termed "bobbin wires," used in the manufacture of caps and bonnets; or the wires may be covered with threads in a plaited or braided form, by means f a braiding-machine; such description of covering being much stronger and less likely to be disturbed or rubbed off when passing through the machinery hereafter described, than the coiled coverings of the ordinary bobbin-wires, or any other description of covering hitherto employed for that purpose. As the liability of the wires to come into contact, and thereby disturb the electric circuit, is greatly diminished by braiding their surfaces, the patentees consider this mode of protecting the wires as one of great importance in the construction of electrical conductors.

The wires so covered are to be introduced into and enclosed within a tube or pipe, composed of lead or other similar soft metal; which tube or pipe is filled with asphalte, pitch, wax, resin, or other substance, being a nonconductor of electricity, and capable of being liquified by heat, and afterwards becoming concrete by cold.

The wires being covered with thread, as above mentioned, are prevented from coming into contact with each other, or with any adjacent conducting medium which might divert the course of the electric fluid; and the spaces between the covered wires being filled with pitch or other suitable nonconductor of electricity, as before mentioned, and enclosed in pipes or tubes of lead, or other soft similar metal, the wires will be effectually preserved in an insulated state, and protected from damp as well from other sources of injury.

The means of manufacturing the improved electric conductors will be best understood by reference to the drawings in Plate XII. Fig. 1, is an elevation, partly in section, of a machine for effecting this object. *a*, is a cistern or vessel, formed of iron or other suitable material, for containing the bituminous or resinous matters which are intended to surround the wires in the leaden pipe; *b*, represents a tubular or hollow rod or mandril, open to and descending from the bottom of the vessel *a*; which mandril is preferred to be made of polished steel, and fixed, by means of flanges and screw-bolts, to a triangular plate or head, *q*. *c*, is a tubular core at the lower end of the mandril *b*, also made of polished steel; and *d*, *d*, is a circular hollow die, resting on the top of the ram *e*. The ram *e*, is cylindrical, having a perpendicular opening through its centre; the lower part of the ram is enlarged at *f*, with a transverse slot through it, and is bolted firmly upon a triangular plate *s*. *g*, is a piston, working in the hydraulic-cylinder *i*, having a projection or enlarged diameter *h*, to be packed with leather or otherwise, so as to fit the cylinder *i*, accurately. This cylinder is of cast-iron, bored, and lined with copper, and is bolted to the ground; *k*, is a ring or cap-plate, over the end of the cylinder, embracing the smaller diameter of the piston *g*, which is to be properly packed; *l*, is a malleable iron cylinder, having a chamber *m*, within it, and an aperture to admit the sliding tubular mandril *b*; it is also provided with a small opening at *o*, for filling the chamber *m*, with lead or other soft metal. *p*, *p*, are pillars, fixed upon the plate *q*, and intended to support the cistern or vessel *a*; the plate *q*, has an aperture in its centre to admit the tubular mandril *b*, shown in the drawing. *r*, *r*, are three sliding-rods (two only are shown in fig. 1,) which pass through the snugs or ears of the plate *q*, and are fastened thereto by nuts; their other ends are attached in the same way to the plate *s*. These rods pass freely through a heavy circular plate *v*, which, by means of a ring-plate bolted to its under surface, supports the cylinder *l*; a ledge or belt being provided at *x*, to rest upon the inner edge of the plate *y*. *z*, *z*, are six iron pillars, with screw-nuts at their ends, for binding the plate *v*, to the cylinder *i*.

The covered wires which form the electric conductors *a*, are intended to proceed from reels, placed in convenient situations (but which reels are not represented in the drawings), and pass through the vessel *a*; the reels should be loaded with a weight or drag to keep the wires always at a certain tension.

The relative position of the hollow circular die *d*, *d*, with regard to the tubular core *c*, of the mandril, will be clearly seen in fig. 1. The core *c*, is screwed into the tubular mandril *b*, and is tapered off and terminates before it reaches the most contracted part of the opening in the hollow circular die *d*.

The mode in which the machine operates is as follows:—The wire or wires, covered as before described, are introduced into the machine through the vessel *a*, where they become coated with pitch or other similar material. They are then brought down through the tubular mandril *b*, the hollow core *c*, the hollow circular die *d*, and the tubular ram *e*, to the opening at *f*, where they issue from the machine. The asphalte, pitch, wax, resin, or other nonconductor of electricity, capable of being liquified by heat, and afterwards becoming concrete by cold, is put into the vessel *a*, and brought to a liquified state by means of heat applied to that vessel. The liquified pitch, or other similar substance, will descend into and fill the tube of the mandril *b*, and the hollow core *c*, and during its passage down the said mandril, the pitch or other matter will remain in a liquified state. The chamber *m*, of the hollow cylinder *l*, is filled with lead or other similar soft metal, introduced in a molten state through the opening at *o*. The metal in this chamber is to be forced therefrom by the action of the hydraulic ram, when in either a heated or cold state; but the patentees prefer to operate upon it in a heated though solid state, varying from 250° to 400° of Fahrenheit's thermometer. This degree of temperature may be preserved in the cylinder by any convenient means.

When the chamber *m*, is filled with lead or other metal, the said mass of metal will assume the form of a thick hollow cylinder or tube, of which the mandril *b*, and the core *c*, form the centre. The cylinder *i*, and piston *g*, constitute a common hydraulic press, and water being forced into the cylinder *i*, at the opening *w*, below, by means of force-pumps in the usual way, the piston *g*, will be made to ascend, and with it the ram *e*, and the whole of the superstructure attached to the plate *q*. As the ram ascends, it will force the hollow circular die *d*, against the mass of the lead or other metal in the chamber *m*, which, having no other outlet than the channel between the core *c*, and the hollow circular die *d*, the thick cylinder of lead in the chamber *m*, will be forced into the form of a small pipe or hollow tube, and descending through the tubular ram *e*, will be delivered finished at the opening at *f*, with the wires firmly secured and enclosed within it.

When the charge of lead has been pressed out of the chamber *m*, it is again to be filled with melted lead or other metal, to be operated upon in the same manner, and the charge repeated, until a proper length of tube is produced. The metal being hot when it is poured in, will amalgamate with the remaining metal of the previous charge, so that one continuous perfect tube will be formed. Previously to commencing the operation of forming the pipes, the wires must be carried down to the opening at *f*, and when the first portion of the pipe is produced, it must be made fast to the wires; the further operations will then draw down the wires from the reel or coil, through the pitch vessel *a*, and tubular mandril; so that the pipe or tube, during its whole formation, will always have the wire or wires and the nonconducting material enclosed within it.

The screws at each end of the rods *r*, and corresponding nuts, are intended for adjusting the mandril and die. The vacancy formed in the cylinder *i*, between the projection *h*, in the piston *g*, and the ring *k*, is to admit of water being injected through a small opening by force-pumps, for the purpose of accelerating the descent of the piston.

Figs. 2, 3, and 4, represent various views of another construction or arrangement of machinery, which is a modification of the one above described; for although the arrangement of the parts is somewhat different, the principle upon which both machines are constructed is the same, and the effect produced is identical in both. Fig. 2, represents the machine in vertical section. As many of the parts in both arrangements are the same, their situation only being changed, it has been thought unnecessary to give a detailed description of this machine; but similar letters of reference are employed to denote the corresponding parts. The hollow mandril in this machine is made of much greater length than that in the first described machine, and the position of the core and die is consequently changed, which is poured in at the top, by raising the ram or plunger *e*, out of the chamber. In this machine the hollow mandril and the die do not move up and down with the other moveable parts, but are stationary, and only so far moveable as to allow of their proper adjustment. The die *d*, is placed in a recess made at the bottom of the malleable iron cylinder *l*, and is secured therein by means of a plate *d**, bolted to that cylinder. Through the cover of the hydraulic cylinder passes the hollow mandril *b*, surrounded by a strong tube *a*, which is a prolongation of the piston *g*.

The ram *e*, is firmly bolted to the lower end of the piston or plunger *g*, and the hollow mandril *b*, which, at this part, is contracted in diameter, is passed through it. The lower end of the ram *e*, is furnished with a steel plate, which accurately fits the chamber *m*. The cylinder *l*, is suspended in a strong circular plate *v*, firmly secured to the frame work, and is prevented from moving from its seat by means of a ring *y*, which is bolted to that plate. *q*, is a circular plate, supported from the top flange of the hydraulic cylinder, *i*, *i*, by means of rods, and has an aperture in its centre, through which the hollow mandril *b*, passes; *j*, is another plate, supported above the plate *q*, upon vertical worm-shafts *a**, *a**, which pass through holes made in the plate; and to the centre of this plate *j*, the hollow mandril *b*, is secured in such a manner that by moving the said plate *j*, up and down, the hollow mandril is moved also in a corresponding ratio. The vertical worm-shafts *a**, *a**, each carry a toothed pinion *b**; and upon a horizontal shaft *c**, mounted in bearings on the plate *q*, are small endless screws or worms *e**, *e**, which gear into the pinions *b**. When the pinions *b**, *b**, are made to revolve, the worm-shafts *a**, *a**, will raise or lower the plate *j*, and, consequently, the tubular mandril *b*, to which it is secured. By this contrivance the distance between the core *c*, and the die *d*, is regulated, and, consequently, the thickness of the pipe is determined with the greatest nicety.

The mode of operating with this machine is very similar to that first described. The wires being enclosed in tubes or pipes, filled in the manner aforesaid, may be laid down or otherwise used, either above ground in the open air, or underground, or below the surface of water: and when so constructed, according to this improved method, will present outwardly the appearance of a common leaden or soft metal pipe. The improved conductors may be manufactured, by the machinery and means described, in long lengths, and may be rolled upon reels. If the electric conductors are to be used in great lengths on land, it is proposed to carry them on reels, on a wheeled carriage; and while the pipe is being laid down, one end is to be held fast, as the carriage proceeds in the direction in which the pipe is to be laid, so that the reel may revolve on its journals or centres, and thereby allow the pipe containing the wires to be unwound and delivered on the ground, without risk of injury, and with great facility. Should the conductors be required to be laid in water, it would be advisable to employ a floating vessel, propelled at a suitable speed, by drawing upon ropes or chains, made fast to the bottom or banks; or by steam-boat machinery, applied so as to regulate the speed.

When the electric apparatus is laid down or used on land, it may be laid in a trench made in the ground; and at regular or convenient distances, the ends of the pipes should be raised above ground, and placed in a cast-iron or other suitable case or box, provided with a lock or other means of safe keeping, so that the wires may be easily accessible to the examination of parties wishing to communicate intelligence by them. The ends of the individual wires may also be disconnected from each other in these boxes, and the circuit with the corresponding wires belonging to the adjoining tube completed, when required, by means of small pinching screws, or by causing the ends of the wires to dip into a hollow space, filled with mercury, or an amalgam of that metal, so as to produce metallic contact, in order that the conductors may be so joined as to form a continuous length to any extent, but capable of being disconnected when required.

For this purpose the patentees propose to employ an apparatus, shown in plan view at fig. 5, which represents the terminations of two pipes of soft metal, each containing three conducting wires *a, b, c*. The ends of these wires extend beyond the termination of the pipes, and are bent downwards into cups of mercury *g, h, i*. By this means the connection of the conductors is restored through the mercurial medium; that is, the conductor *a*, by its end being immersed in the cup *g*, communicates with the wire *d*; and the wire *b*, in the cup *h*, communicates with the wire *e*; and the wire *c*, through *i*, with *f*; connection is also made with the outsides of the pipes A, and B, by thick wires *k*, and *l*, soldered to the pipes, which are made to communicate through the mercurial cup *m*. This apparatus, placed at any desired part or parts of the line of communication, may be enclosed in a box *n*, and locked up securely.

The improved electric apparatus may be used not only as conductors for telegraphs, either by land or water, but also for firing mines, or other purposes for which electric conductors have been or may hereafter be employed. It is likewise proposed to use the leaden or other aforesaid metallic pipes or tubes, as means of returning the electric currents conveyed by the metallic wires enclosed in such pipes. Metallic contact is produced through the whole length of these tubes, so as to complete the electric circuit, either by soldering a piece of copper or other metal to each end of the leaden tubes, and bringing these pieces of copper or other metal into metallic contact through the mercury, or by other means, as above said.

When the conductors are used for electric telegraphs, these ends and the wires enclosed therein are attached to the wires proceeding from the clockwork of such telegraphs, in the usual way; but which may vary according to the construction of such telegraphs. If the conductors are to be employed for igniting gunpowder, a short piece of metallic wire, of small diameter, may be placed in any convenient situation, so as to form a part of the electric circuit; and if the electric current be sufficiently powerful, this small wire will be made hot enough to ignite gunpowder, when a current of electricity passes along the wires.

The patentees, in conclusion, state, that they do not intend to claim the adaptation of wires, surrounded with nonconducting substances, enclosed in tubes for electric conductors; but that which they do claim is, the construction and manufacture of electrical conductors, by the employment of machinery having a tubular mandril or hollow rod, through which wires may be drawn, whilst the leaden or other soft metal tube is forming, by pressure between a core and die; such wires being at the same time imbedded in pitch or other nonconducting material.

PROPELLING ON RAILWAYS AND CANALS.

William Hannis Taylor, of Piccadilly, gent., and Francis Roubiliac Condor, of Birmingham, civil engineer, for "*certain improvements in propelling*,"—Granted December 20, 1845; Enrolled June 20, 1846. (*See Engraving, Plate XII.*)

The object of this invention is to propel a train of carriages by means of electro magnetism in connection with the atmospheric principle, in the following manner:—A tube *a* is laid betwixt the rails throughout the whole length of the line, having two pistons *b* moving within it, similar to the present mode of working atmospheric railways, with this difference, that in place of forming the connection between the piston and leading carriage by means of an arm passing through the longitudinal opening. The inventors effect the above by means of powerful magnets *c* attached to one or more of the leading carriages of the train. On the top of the atmospheric tube *a*, which is provided with an opening of about three inches wide, there is firmly fixed a rectangular box of copper, *d*, projecting above the tube about three inches, so that the longitudinal opening is covered as it were with an inverted trough. Within this box there is a piece of soft iron, *e*, supported from the piston by means of a wood frame and arms, *f*. The magnets *c* are bent of such a form that the two ends or poles approach the sides of the copper box, or covering to the longitudinal opening, and fixed to the underside of the carriage; then being charged with the magnetic influence, by a galvanic battery, are attracted by the piece of iron *e*, attached in the manner before described to the piston, so that the connection between the carriage and the piston is effected by means of powerful magnets, in place of an arm passing through the longitudinal opening as heretofore.*

* The application of the above principle will be found in the specification of a patent granted to Mr. Henry Pinkus, in the year 1834.

CONNECTING OF BOILERS.

James Garforth, of Dunkinfield, Chester, engineer, for "*certain improvements in machinery, or apparatus for connecting of boilers, and other purposes*."—Granted December 10, 1845; Enrolled June 10, 1846. (*With Engravings, see Plate XII.*)

These improvements for connecting metallic plates for the construction of steam boilers consist in the direct application of the expansive force of steam to the dies for rivetting the plates together, and in the machinery or apparatus, whereby such force is brought into action. Fig. 1 is a side-view of an arrangement of machinery for rivetting metallic plates for the construction of steam boilers, and fig. 2 is a vertical section of the cylinder; *a, a*, is the frame work supporting the steam cylinder *b, b*, in which a steam-tight metallic piston *c*, is mounted upon the rod *d, d*, which passes through stuffing boxes *e, e*, at each end of the cylinder *b*; in the end of the piston-rod the die *f* is fixed, the other die *g*, being mounted in the pillar *h*, which is firmly secured to the frame-work. Steam being admitted through the entrance or feed-pipe *i*, it passes onwards through a common slide or other valve *k*, to the cylinder, and after having performed its office, is allowed to pass out through the pipe *l*, the slide valve *k*, being worked by hand by means of the lever *m*, so as to admit the steam on either side of the piston, as required.

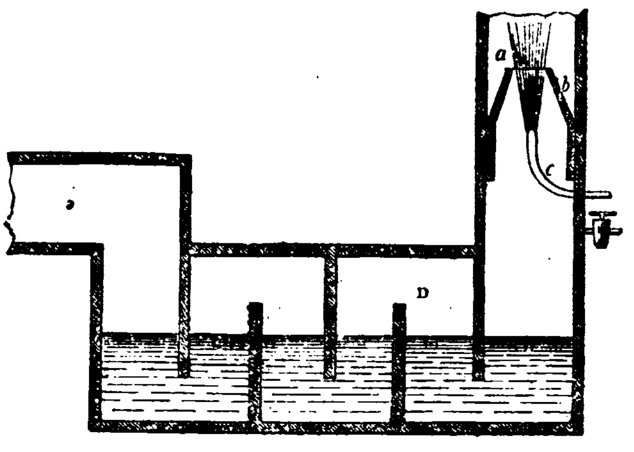
The operation of the apparatus is as follows:—steam of sufficient pressure being admitted by means of the slide valve *k*, on the left hand side of the piston *c*, it will force it, together with the piston rod *d* (to which is attached the die *f*), against the head *g*, which forms the end of the rivet *n*, between the dies *f* and *g*; thus firmly connecting the plates *p*, thereby producing a perfectly steam, air, or water-tight joint. The head of the rivet being formed at one or more blows as required, the intensity of the blow depending upon the area of the piston, the length of the stroke, and the pressure of the steam employed. The valve *k*, is then reversed, the steam admitted on the other side of the piston, which movement will withdraw the die *f*, when another rivet may be introduced and the operation proceed as before.

The inventor does not confine himself to the use of steam pressure, as the direct action of water, air, or any other elastic medium, may be similarly employed without departing from the principle of his invention. He does not claim as his invention the exclusive use of the several parts of the above machine, except it be employed for the purposes of his invention, which consists in rivetting metal plates by dies driven by the elastic force of steam, water, or other elastic medium as above described.

CHIMNEY DRAUGHT.

Henry Watson, of Newcastle-upon-Tyne, brass-founder, for "*Improvements in withdrawing air and vapours from furnaces or other apparatus, and in condensing and employing such vapours*."—Granted January 6; Enrolled July 6, 1846.

This invention relates to introducing a jet of steam through a cone fixed in a chimney, to create a draught and for withdrawing the air and vapours. Fig. 1, *e* is a section of a flue, with a cone *b* fitted inside, and made to



slide, so as to regulate the proper position for preventing a back draught. *c* is a pipe for introducing a jet of steam through the aperture of the cone, and for producing a partial vacuum below the opening; the inventor also shows how a chamber, D, to be used as a condenser, may be connected with the apparatus when a draught is employed for the purpose of reducing ores, such as lead. *e* is the flue, leading from the furnace. D, the chamber, half filled with water, and divided into compartments by partitions alternately dipping into the water. As the vapour passes from the flue *e* it will, the inventor states, on account of the partial vacuum created in the cone *b*, be made to pass through the water, and thereby be condensed and absorbed by the water.

STEAM SHIP PROPELLING MACHINERY.

JOSEPH MAUDSLAY, of the firm of MAUDSLAY AND FIELD, Lambeth, engineers, for "*Improvements in propelling and propelling machinery.*"—Granted Jan. 13; Enrolled July 13, 1846.

Fig. 1.

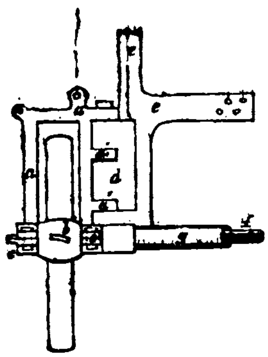
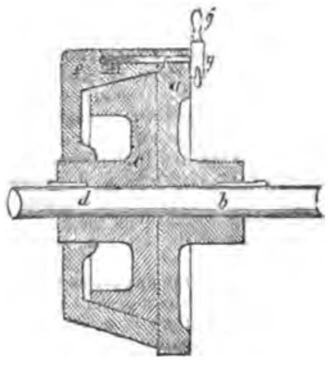


Fig. 2.



This invention consists in a mode of raising screw and other similar stern propellers, when the same are fixed abaft the stern-post. Fig. 1 shows the mode of effecting this object. *a a* is a rectangular framework of iron, which supports at its lower end a hollow shaft *b*, carrying the vanes of the propeller and working freely in the plummer blocks *c c*. The rectangular frame *a a* is provided with projecting pieces *a' a'* which fit into and are attached to a sliding piece *d*, in a similar manner to a hinge joint. This sliding piece *d d* is capable of moving freely upon a strong frame *e e*, which latter is firmly bolted to the counter of the vessel. *f* is the propeller shaft which passes through a hollow shaft or tube *g*, the propeller shaft being squared at its outer end so as to fit the hole formed in the boss or hollow shaft *b*, which hole is of the same figure. *h* represents a chain, one end of which is attached to the rectangular frame *a*, the other being attached to a capstan or windlass on board the vessel. When it is necessary to raise the propeller, the square end of the shaft *f* is withdrawn from the boss or shaft *b*, then, by giving motion to the windlass, the part *d* will slide upon the frame *e e*, carrying with it the rectangular frame *a a* and propeller. The advantages of this arrangement are stated to be, that the propeller may be placed lower down than heretofore, and consequently a larger propeller may be employed, moreover the water passing from the propeller will meet with less obstruction against the sides of the vessel, and which vessel will be less subject to that tremulous motion caused by the action of the propeller.

The second improvement consists in disconnecting the propelling shaft from the driving shaft, thereby allowing the former to run loose upon its axis when the vessel is required to be worked with sails only, or when she is laying in a tide way. In fig. 2, *a* is a circular plate of cast iron, firmly keyed on the outer end of the driving shaft *b*; *c* is a casting in the form of a frustrum of a cone, and is firmly keyed upon the inner end of the propeller shaft *d*; upon the periphery of this conical piece there is a hollow casting *e* turned accurately to fit the conical part *c*. On the periphery of the plate *a* there is cast three "snugs" or projections, through each of which is passed a bolt *f* (one only of which is shown in the drawing); at the outer end of these bolts there is a winch, *g*, or handle, having three projecting arms *g'*, so that one is always uppermost. It will therefore be seen by the above that by screwing the bolts *f*, and the part *c*, the propeller shaft *d* will be driven by the friction of the two conical pieces *c* and *e*, and by unscrewing the conical part *c* and propeller shaft will be allowed to run loose.

ATMOSPHERIC RAILWAYS.

CHARLES WHEELER, of Speenhamland, Berkshire, machinist, for "*certain improvements in the construction and working of railways*"—Granted January 22; Enrolled July 22, 1846.

The first part of this invention is for an improved form of rail for railways, shown at fig. 1, which represents a transverse section of a rail constructed of such a form as to present three different surfaces to the action of the wheels, that is to say, when one surface is worn out, another can be turned up, as will be clearly understood by the following description. *a* is a section of the rail, fastened down to the sleeper by means of cast iron blocks *b*; between the rail and the block a piece of felt is placed, or a key way may be formed in the blocks, as shown at *d'*, and a hard wooden wedge driven. The rails are further secured to the sleepers by means of a half round piece of wood *c*, upon which the rail is made to rest. The specification states that this description of rail may be made by rolling the bars of iron betwixt three rollers.

The second part of the invention consists in transmitting motion from the piston of an atmospheric railway to the carriage by having a flexible covering to the top of the tube, which is raised up and forced against a wheel attached to the leading carriage by means of a wheel attached to the piston.*

Fig. 1.

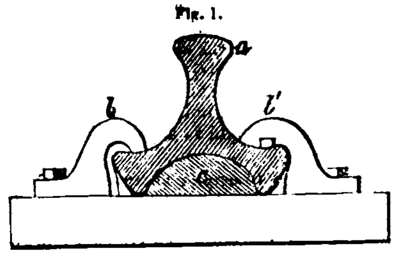


Fig. 3.

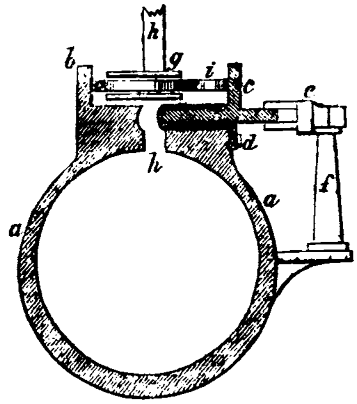


Fig. 2.

The third part of the invention relates to a mode of closing the longitudinal opening by means of a continuous sliding valve, shown at fig. 2, which represents a transverse section of the pipe and sliding valve constructed according to this part of the invention; *a* is the tube, which is cast with a projecting rib *b*; *c* is a sliding plate, also having a projecting flange similar to that upon the pipe; a number of these plates are hinged together with a rule joint, so as to extend the whole length of the line. Upon the underside of this sliding plate there is a piece of leather *d* firmly attached to the side of the pipe, which piece is brought over the longitudinal slit or opening by the inner edge of the plates *c*, the outer edge of such plates being acted upon by means of springs *e*, supported at intervals by pillars *f*, which have a tendency to force the plate *c* and leather over the opening. *g* is a framework of iron attached to the vertical arm *h*; this framework supports three anti-friction rollers which, as the piston travels along, forces back the plate *c*, so as to allow the vertical arm to pass, the opening being closed again by the action of the springs *e*. Fig. 3 shows a plan of the framework *g* and rollers *i*.

* This mode of forming the connection has already been patented two or three times over.

DECORATION OF HOUSES.

HENRI AUGUSTE BEX, of Great Titchfield-street, Marylebone, decorator, for "*A new method of drying, polishing, and colouring marble, stone, and certain other materials used in the construction or decoration of houses and other buildings.*"—Granted December 10, 1845; Enrolled June 10, 1846.

The improvements are: First, in polishing marble and stone by filling up the pores with plaster of Paris or marble cement; then rubbing them with hard stones, applying a thin layer of plastic before each rubbing; and lastly rubbing them with wax, or a mixture of wax and turpentine. Secondly, in polishing other materials used in the construction or decoration of houses by rubbing them with a varnish of gum lac. Thirdly, in dyeing and colouring marble, stone, and other materials used in the construction or decoration of houses, by wetting them with certain acids, salts, and colouring materials or their chemical combinations, by means of a brush or sponge.

The inventor then proceeds to describe the manner in which the said invention is to be performed. To polish marble or stone the surface to be polished is first rubbed with a piece of sandstone, and afterwards with a sandstone of a finer description, in same manner as is now ordinarily practised; the pores of the marble or stone are then stopped up with plaster of Paris mixed with a thin solution of gelatine and some colouring matter, to render it of the same colour as the marble or stone to be polished, till it attains the consistence of cream, or else marble cement mixed with colouring matter, till it attains same consistence, and is similarly coloured. These mixtures are then laid on respectively, as the case may be, with a brush, and afterwards scraped off with a wooden knife, taking care that all the pores of marble or stone are filled up. The marble or stone is then rubbed with a kind of sandstone called Charley Forest stone; the pores being stopped up, are rubbed with the stone, and after that with a piece of German stone, and finally with a piece of touchstone; before each of these rubbings there is laid on with a brush a thin coat of plaster of Paris or marble cement, mixed with water to the consistence of milk; and lastly, should the colour of the stone or marble be clear, a coat of wax, or mixture of wax and turpentine, is laid on and rubbed with a linen, cotton, or woollen rag, till the marble or stone becomes perfectly polished, but if the colour of the marble or stone should not be clear before applying the wax, or mixture of wax and turpentine, it is rubbed with linseed oil till the colour becomes clear, taking care to remove all the oil before the wax is applied. In addition to the above process, sometimes the marble or stone to be polished is rubbed with a piece of jasper, if a very brilliant polish is required. Other materials used in the construction of houses are to be polished in same manner as the marble and stone above described, till the rubbing is completed with the Charley Forest stone; they are then rubbed with linseed oil, taking care to wipe it off thoroughly, and then varnished with gum lac in the following manner:—Take a ball of wool, wet the surface of it with the varnish, and cover it with a linen rag. Then well rub the material to be polished, adding a little oil occasionally, if the varnish should not work freely. To dye and colour marble or stone, and other materials used in the construction and decoration of houses, the same system of acids, salts, or colouring matter is employed as generally used by dyers in dying cloths and other textile fabrics. The said acids, salts, or colouring materials, or their chemical combinations, are applied in a liquid state, over the surface of the material required to be dyed or coloured by means of a sponge. If the dyed or coloured surfaces are to have the same polish as the rest of the surface, the said colouring materials are applied before polishing the said substance, or when the process of polishing is only half finished; but if it be wished the dyed or coloured matter to be dead or unpolished, the colouring materials are applied after the process of polishing is completed. The certain other materials alluded to in his title are plaster, stucco, scagliola, and a species of stucco invented in France, and introduced by the inventor for the first time in England, and which is called *stuc à la brosse*. The claims are:—First, the filling up with plaster of Paris, or marble cement, in the manner above described, the pores of the marble or stone intended to be polished, and rubbing them with certain hard stones, as hereinbefore described; secondly, the polishing of certain other materials used in constructing or decorating houses, &c.; and thirdly, in dyeing and colouring marble, stone, and other materials, as above described, by wetting them with certain acids, salts, colouring materials, or their chemical combinations, as above described, by means of a brush or sponge.

GRAND BLAST AT THE DOWNHILL TUNNELS, LONDONDERRY AND COLERAINE RAILWAY.

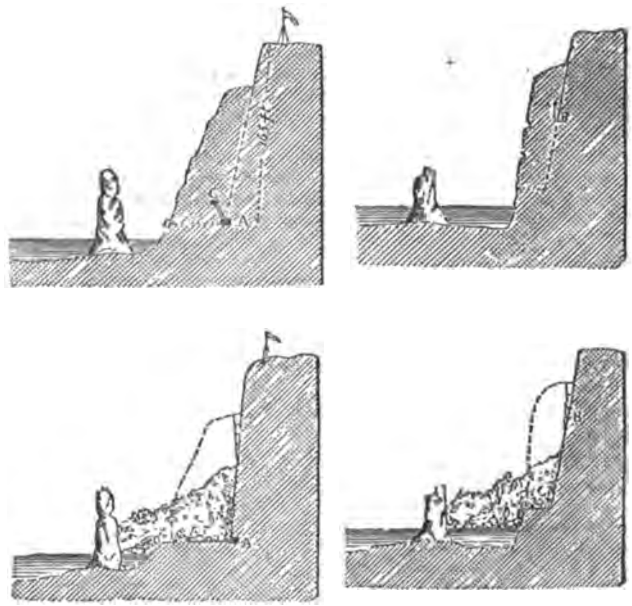
The novel nature of the undertaking proposed by the Londonderry and Coleraine Railway Company, has, from its first appearance before the public, invested that project with peculiar interest to scientific and the monetary world.

Lough Foyle, a deep indentation of the sea on the northern coast of Ireland, covers an area of about 60,000 acres. With the exception of the channel along the Donegal shore, leading up to the port and city of Londonderry, the tide in this lough does not generally rise more than six feet, and, at low water, a large portion of its area is left perfectly dry, exposing a slob formed of the richest alluvial deposit, capable of immediate conversion into valuable soil. The situation of the lough—almost land-locked, protected from the swell of the Atlantic by its narrow entrance, and sheltered from the prevailing westerly winds by the mountainous nature of the country on the Donegal coast—is such as at once to suggest the idea of facility for shutting off the sea, and reclaiming a great portion of the slob land. In the Session of 1837, an Act of Parliament, authorising this reclamation, was obtained, and two enclosures were made, winning from the sea about 4000 acres, upon part of which luxuriant crops have already been reared. In 1844, public attention became alive to the necessity for establishing railway communication between the important towns of Londonderry and Coleraine. The mountainous nature of the interjacent country, rendered a line inland impracticable. and the idea was conceived of combining the Railway and the Foyle reclamation, making one embankment serve for both. With this object a Company was formed; terms were arranged with the parties in whom rested the powers under the Act of 1837; and, in the Session of 1845, the Londonderry and Coleraine Railway Company obtained its Act of incorporation.

The length of line proposed by this Company is 30 miles, including a branch to the town of Newtown-Limavady—15 miles to be constructed on an embankment through Lough Foyle; and by which embankment about 22,000 acres of land will be recovered from the sea. Of this reclaimed land, 12,000 acres are set apart to cover the expenditure on the railway. The works are now so far advanced, that by the end of the present year the Directors anticipate being in a position to enclose and sell a portion of the land; and, as the works proceed, like portions may from time to time be enclosed and sold.

The line, after leaving Lough Foyle, proceeds eastward across Magilligan Point, and along the coast towards Coleraine. About seven miles from the latter town, and close to Downhill, the beautiful residence of Sir Hervey Bruce, Bart., it passes through the cliffs between Downhill House and the sea by two tunnels, one about 700 yards and the other about 300 yards in length. The works upon those tunnels have been some time in progress by the ordinary process of picking and blasting; but it being deemed necessary to expedite their construction, it was determined to effect the removal of the obstructing rock by one grand blast.

ROCK BEFORE THE EXPLOSION.



ROCK AFTER THE EXPLOSION.

We are indebted to the Illustrated News for the following particulars relative to an extensive blast which took place at Downhill, about 7 miles from Coleraine, on the 6th June last:—"The mass of rock which it had been originally necessary to remove was at the western mouth of the large tunnel, and measured nearly 60,000 tons, the material being the hard basaltic stone, in which the coast of Antrim and Londonderry abounds; a large portion of this rock had been previously removed by the common slow process already named. Having resolved upon the large blast, Messrs. Bromhead and Hemming, the contractors, formed a heading or gallery into the rock, from the side of the cliff, 50 feet in length: at the end of this, a shaft was sunk, 22 feet to the level of the railway, as seen at C A; and again another gallery at the bottom, running at right angles to the first gallery, and further into the rock, was made for 10 feet. At the end of this was placed the large charge of powder, 2,400 lb., shown at A. The whole was then well filled up, and tamped with clay and masonry, and the wires to convey the electric fluid from the battery through the charge were carefully arranged. The smaller charge, which was higher up in the rock, and which is seen at B, contained 600 lb. of powder; and the gallery B F leading to it was about 70 feet in length; this was also tamped in a similar manner to the larger one. The galvanic battery, which stood on a shed on the top of the cliff, was a very powerful one, consisting of 18 cells, each cell about 14 inches square.

The operations were conducted by Mr. Hemming and Mr. Webb, Superintending Engineer to the Contractor. Mr. M'Leod, acting under Mr. Robert Stephenson, the Engineer of the Company, was present, with Mr. Langon, and other civil engineers. There were also several royal engineers and scientific gentlemen who had come from different quarters of the country to witness the explosion.

At the appointed hour some little delay occurred in connecting the wires with the battery; but, at half-past three o'clock, the two poles were united, and instantaneously the bottom of the rock was seen to heave out for a moment, the mass of rock above stood, trembled, and, cracking into a thousand fissures, rolled into the sea beneath. A deep and hollow sound was heard, like distant thunder, but *no report*. The quantity of rock removed must be upwards of 30,000 tons. The effect will be seen by referring to the accompanying profiles or sections taken through the lines *a a b b*, in the front view, both before and after the blast. The result, in an engineering point of view, was perfectly successful, and reflects the greatest credit on the gentlemen superintending the operation.

The dotted lines show the quantity of rock to be removed. A is the larger chamber, containing 3400 lb. of gunpowder. c, the heading leading to it, which is 50 feet in length. B, the smaller chamber, containing 600 lb. of powder. A x, the line of least resistance—50 feet. From A to the top of the cliff—165 feet.

THE GAUGE COMMISSION.

Analysis of Evidence given before the Royal Commissioners appointed to investigate the subject of the diversity of Railway Gauges.

(*Continued from page* 214.)

Mr. Edward Bury: Is a manufacturer of locomotive engines, and has been such for 17 years. The heaviest engine made by witness has not exceeded 13 tons. 14-inch cylinder the largest yet made by witness; evaporating surface in proportion to the cylinder. Length of boiler increased from 8 feet 6 inches to 11 feet 6 inches. Space between fore and hind axle very considerably increased; interval 7 feet 6 inches. Witness considers that the speed now attained on narrow gauge lines as great as consistent with safety. The securities for the rails not sufficient to justify a higher rate of speed.

The transverse sleeper better than the longitudinal. There is a better chance of keeping the transverse sleeper right than the longitudinal sleeper; there is a great deal less packing with the transverse sleeper than the longitudinal sleeper; the under surface of the longitudinal sleeper is too great to admit of its being thoroughly and uniformly packed. Greater speed can be obtained on broad gauge than on narrow, because the speed depends upon the ratio of the stroke to the wheel, and on broad gauge a longer stroke and larger wheel can be had. The narrow gauge trains, however, can travel faster than is necessary or safe. If the Midland Counties were changed to broad gauge, the inconvenience to the London and Birmingham Company would be so great that they would be compelled also to change to broad gauge. Does not consider the rigidity of the rail essential to safety at high velocities; it would be better with a moderate elasticity in it. The best part of the Liverpool and Manchester Railway, and the most easily maintained, is that which occurs at Chat Moss, which is always elastic. The most difficult part to maintain on the Liverpool and Manchester line was that which went through Olive Mount, which is on a stone foundation. They have been obliged to take the stone out for a considerable depth under the rails and fill it up with ballast. The engineer of the Bolton and Manchester line was anxious to make that line perfectly rigid. He built a continuous wall, and put it upon a T rail; but that did not stand at all; it knocked everything to pieces; it was always out of order, and they have been obliged to change it. The rail itself ought to be rigid, and the foundation on which it is placed should be elastic. Does not think any of the rails that have hitherto been laid are heavy enough. Has no knowledge of the feeling of proprietors in the mineral districts with respect to broad or narrow gauge, but considers that the narrow gauge is more suitable to their traffic, because the curves can be made sharper than on broad gauge, and bring them closer to the pit's mouth. Prefers a wider gauge than 4 feet 8½ inches, which witness believes too narrow for the engines and carriages and machinery working on the rails. 6 or 8 inches' additional width would be amply sufficient. Does not at present use outside cylinders, but some are now being made. Can get sufficient power on the narrow gauge, but a more convenient and accessible machine, with greater range and capability, could be constructed with a little additional width of rail. If witness had to determine on the gauge for a country having no railway, should certainly not adopt the 4 feet 8½ inch gauge. Would not adopt the 7 feet gauge. Should adopt an intermediate gauge, as preferable for engines, carriages, and wagons. Strength of passenger carriages on London and Birmingham Railway considerably increased, weighing 10 or 12 cwt. more than when the line was first opened; this increased strength essential to public safety as well as to the durability of the carriage. Reserve fund appropriated to purchase of new engines. Stock deteriorated within the last half-year in consequence of being compelled to run the engines, &c., longer without the usual repairs, on account of the heavy traffic on the line.

Stock of Great Western Company valued at £534,000; of the London and Birmingham at £275,000, the latter doing the most work; difference accounted for by inferior size and expense of engines on London and Birmingham line. With the additional stock the expenses will come nearer the expenses of the Great Western Company. The 175 miles now worked with the original stock of the line. They have 93 engines and one borrowed from another Company.

Accidents from breaking of axles of rare occurrence; not one carriage axle broken within the last five years, and very few engine axles. The fracture of axle usually occurs in the journal; outside the wheel in the carriages, and inside the wheel in the engines. Engines frequently run some distance with a broken axle; have never had one so crippled as to be unable to get home; some have even taken out trains with a broken axle. The train taken off the line from broken axle in only one instance, when the front axle of the engine broke. Increased length of engine gives increased steadiness. Messrs. Sharp are manufacturing an engine with 18-inch cylinders; the cylinders are not placed outside the wheels, but inside, so that there is room for two 18-inch cylinders with the narrow gauge to be constructed inside the wheel with the crank shaft. Impossible to say what load an engine can be made to take on narrow gauge, but considers that for the ordinary traffic of the country, an engine on narrow gauge may be made of sufficient power to take at high speed both passenger and luggage trains. Present luggage engine on London and Birmingham line too small. Luggage trains often worked with several engines. The heaviest luggage train on this line was a train of 112 or 116 wagons, making upwards of 600 tons; for this train four engines were used.

Long trains much impeded by high winds. Has seen the transverse sleepers pushed out of their places, sometimes twisted like the letter S, by the expansion of the rail; this has occurred when sufficient allowance was not made between the rail for expansion. Average speed of express trains on London and Birmingham line 43½ miles an hour, including stoppages. They now use 13-inch cylinders; some of their engines for the express trains have been altered, by increasing the size of the boilers, an additional inch to the cylinders and three inches to the wheel. Does not think it safe to run a small train very fast; should prefer more weight on the engine to make it run steadier; when any of the royal family are on the line, always put more carriages on than are required for passengers, in order to steady the train. Has frequently travelled by express train on London and Birmingham; there is very little oscillation; thinks the express train steadier than any other because it is better screwed up; everything is in higher order. Outside cylinders not yet tried on this line; they were tried on the Liverpool and Manchester and condemned; the oscillatory motion objected to; the boilers, however, were shorter than they are at present; there was a greater tendency to the yawing motion. Decidedly objects to the use of carriages with shifting wheels on account of the difficulty of keeping the securities always right. Experiments have been made in the United States to allow wheels to adjust themselves on curves; they were soon abandoned, it being impossible to keep them in order. A very small increase on the narrow gauge would afford great accommodation in the construction of the engine. The difficulty of oiling and cleaning the narrow gauge engines a very great inconvenience, and can only be felt by engine-makers. They require more space for the tube of boiler, and a larger fire-box.

Mr. Benjamin Cubitt: Does not think an equal power can be obtained on narrow as on broad gauge. The narrow gauge does not allow width enough to get a fire-box large enough, and is cramped for width in getting strength for the working parts of the engine. Thinks it impossible to make so effective a boiler for narrow as can be made for broad gauge.

Has not particularly considered the relative advantages and disadvantages of outside or inside cylinders. There are about half-a-dozen outside cylinders upon the lines of which witness is superintendent. Total stock of engines about 120; all but 16 on 6 wheels. The Dover Company have ordered a large number of outside cylinders. Has ridden a good deal upon the outside cylinder engines. At first they travel as steadily as the inside cylinders, till they have been at work eight or ten weeks, and then they begin to get side play and oscillate a good deal. This motion increases with the wear. The repairs upon outside cylinder engines are not more costly than upon inside cylinder engines.

The repairs required on the outside cylinder engines.

No. of Engine	Maker	Description.	Continued Working.	Miles Run	Coke used. Total	Coke used. p. mile	Cost of Repairs.	Heating surface. Fire-box.	Heating surface. Tubes.
					Cwt.	lbs.	£ s. d.	sq. feet	sq. ft.
42*	Sharp and Co.	Crank axle with outside bearings.	Feb., 1844, to April 12, 1845.	40,135	11,304	31·54	137 8 8	60	[illegible]
43†	Bury and Co.	Crank axle with inside bearings.	Aug., 1844, to April 12, 1845.	14,626	5,[illegible]	35·07	100 7 10	[illegible]	[illegible]
44‡	Stephenson.	Straight axle, with outside cylinders and inside bearings.	Oct., 1844, to April 12, 1845.	18,447	4,867	2,955	67 14 1	55	[illegible]
Bodmer Engine								73	[illegible]

* April 14, 1845.—Taken into dock to have new tyres, axle-bearings, and general repairs.

† August, 1844.—Taken into dock for two new eccentric straps, and temporary repairs.

‡ April 21, 1845.—Taken into dock for new driving-wheels, new bearings in leading wheels, and general repairs.—July 10, 1845: Taken into dock for new bearings to trailing wheels.—July 22, 1845: Taken into dock for leading wheels keyed on to axles, and new axle boxes and bearings to driving-wheels.

In the narrow gauge inside cylinder engine there is scarcely sufficient space for the necessary repairs and cleaning; there is also a difficulty in the outside cylinder to get at the bearings, both to oil and to clean them, without lifting the engine. As a locomotive engine-maker, is in favour of a gauge of 5 feet 3 inches. There is at the New Cross station a new engine of great power, made by Bodmer; he has taken out a patent not only for locomotives, but for steam engines in general, for what he calls a compensating engine, as it works with two pistons in one cylinder, so that the connecting rods pull and thrust at the same time, which takes the strain off all the other parts of the engine, except between the cylinder and the crank. The length of the boiler is 10 feet, the cylindrical part of the boiler. The fire-box is as large as it can be got to suit the gauge. This engine has been tested against other engines and found more powerful than any other with one pair of driving wheels, because it is a larger engine, with a larger boiler, and larger cylinder; the cylinders are 16 inches in diameter, and the stroke is equal to a 30-inch stroke, being four 7½-inch cranks. It has taken 38 carriages upon an incline of 16 feet a mile, about

4½ miles long, at about 30 miles an hour, with a gross load of about 150 tons.

Cannot accurately ascertain the comparative locomotive cost of working goods trains and passengers trains upon this line, the accounts not being separately kept.

Locomotive Expenses of the Brighton, Croydon, and Dover Railways, compared with the Great Western Railway Company, for the half-year ending December, 1844.

—	Great Western Railway Company.		Brighton, Croydon, and Dover Locomotive Comp.	
	Passengers.	Goods.	Passengers.	Goods.
Number of engines and tenders belonging to the Companies .	102	22	83	14
Number at work during the half-year . . .	96	22	77	14
Number of engines in steam each day . . .	85	11	26	7
Average number of miles run during the half-year . .	7590	6720	6555	5252
			Passengers and Goods.	
Average cost per ton per mile .	0·15d.	0·05d.	0·182d.	
Average weight of coke per ton per mile . . .	lb. 0·56	lb. 0·23	lb. 0·587	
Average quantity of coke used per mile run . . .	34·27	51·99	34·98	
Average cost of repairs, including general charges, per mile .	2·81d.	2·51	3·31	
Average cost of coke per mile run	3·88	5·86	4·87	
Average cost of wages per mile run	1·39	1·44	1·49	
Total cost per mile run .	9 90	12·07	11·12	

Dimensions of two engines on Brighton, Croydon, and Dover Railway.

—	Diameter.	Length.	Depth.	Breadth.
STEPHENSON'S ENGINE, SIX WHEELS.	Ft. In.	Ft. In.	Ft. In.	Ft. In.
Passenger Engine, Link motion:				
Cylindrical part of boiler	3 0	12 6	..	..
Outside fire-box	..	3 8	7 8	3 8
Inside fire-box	..	3 0	4 1½	3 0
Smoke box	..	3 0	..	3 8½
Tubes, 150	0 1⅝	13 0½	..	..
Chimney	1 2	..	..	..
Cylinders, 1 ft. 10 in. stroke ..	1 3	..	..	..
Driving wheels	5 6	..	..	..
SHARP'S ENGINE, SIX WHEELS.				
Passenger Engine:				
Cylindrical part of boiler ..	3 6	8 0	..	..
Outside fire-box	..	3 8	7 10½	4 2
Inside fire-box	..	3 0	4 0	3 7
Smoke-box	..	2 1½	..	4 3
Tubes, 98	0 2	8 5	..	..
Chimney	1 1½	..	..	..
Cylinders, 1 ft. 6 in. stroke ..	1 2	..	..	..
Driving wheels	5 6	..	..	..

Distance from Centre to Centre of leading and following Axles.

Stephenson ..	44	Six wheeled, Passenger Engine ..	10 ft. 3¾ in.
Sharp ..	8	Ditto ditto ..	11 3½
Bury ..	23	Four wheeled, ditto ..	7 2
Bury ..	39	Ditto, coupled ..	7 8

The passengers of an ordinary train of 10 or 12 carriages could not be changed from one train to the other under 20 minutes. With engines on narrow gauge, even with outside cylinders, there is more difficulty in getting access to the axles to clean and oil them than in the broad gauge. This difficulty of oiling the axle depends upon the circumstance of the cylinders being outside, and not upon the breadth of the gauge. It is easier to do this with the wide gauge engines; on the crank axles the bearing is taken on the outside of the wheels; on the four-wheel engines the bearings are inside bearings, and there is a difficulty in getting the men to keep those bearings clean. If the gauge were increased from 4 feet 8½ to 5 feet 3, the weight of the engines would be increased from 15 cwt. to a ton. Average weight of engines on South Eastern Railway, about 14 tons; on Great Western about 17 tons. Considers that the general construction of the roads will admit of heavier engines being placed upon them.

Weight of rail upon the South Eastern line 65 lbs. a yard. The bearings average 3 feet apart upon a cross sleeper. The sleepers are triangular; they are four triangles cut out of a 13-inch square. The rails are fastened to chairs with wooden keys; and the chairs are fastened to the sleepers by wooden treenails. The boilers upon Great Western are not much larger than those upon the Brighton line. If witness had the control of the engines of the Great Western, should certainly make larger boilers. There is room to get sufficient strength and cranks, with inside cylinders; but the engine and the boiler have to be raised, which is a great objection. Would like to have the cranks more separated, and keep the boiler still the same height. To give the cranks strength, obliged to make the bearings shorter to get room for the cranks. The thickness of the side of the crank, which is perpendicular to the axis, 4 inches; some 4½. Does not think it necessary to make that thicker; the great advantage would be in getting the bearings longer. The eccentrics are reduced as much as possible. When they are very short bearings, they are apt to heat and get dry; then they cut away the journal, and it is reduced and made weaker. With the present construction of the South Eastern Railway, should venture to increase the speed by having much more powerful engines. The quickest train is upon the Brighton line, which runs from Brighton to London in an hour and a half; that is 50½ miles, stopping once five minutes. The distance is often run in an hour and a quarter; some parts of the distance cannot be run at 40 miles an hour, on account of the gradients; and other parts have to be run at more than that speed, in order to keep the time. There are 120 engines for the three Companies, working 166 miles. This includes the Dover, Brighton, and Croydon, and two miles of branch to the Bricklayers' Arms, and the branch to Maidstone.

William Cubitt, Esq.: The limit to safe speed on narrow gauge lines is the want of evaporating surface and space for the fire boxes, the want of solidity and perfection in the road, the want of base for engines or carriages, the want of greater strength in the rails, and greater security in connecting them with sleepers; many accidents have been caused by attempting to go too fast upon a bad road. And that danger is very much increased by increased velocity. A speed of 15 or 20 miles an hour may be safely attempted on a bad road, while double that speed would throw engines and cariages off the line of road. Attention to the state of the road has not kept pace with the improvement in the driving machine. Before increased speed is attempted that particular should be attended to. The perfection of the permanent way has been less thought about than almost any other part of railway mechanism, and that is the basis upon which it all rests. Does not think that the speed might be increased, without a corresponding increase of danger to the traveller, by adding to the width of the narrow gauge; considers the narrow gauge wide enough for safety at almost any practicable speed, but not wide enough to get the most perfect machinery for speed. An addition of 6 or 8 inches over the present narrow gauge is wide enough, perhaps, for all practical purposes of machinery of locomotive engines and carriages. A gauge of about 6 feet would be the best. Has often heard that an increase of gauge would involve the necessity for widening the tunnels; does not concur in this opinion; if the size of the largest loads is not altered, nothing need be altered but the gauge. Does not think that if they had carriages upon a wider gauge, they would wish to carry larger loads; in railway operations would rather adopt the same width, making the vehicles of greater length, which would produce greater safety and greater convenience than by shortening them, so as to produce greater width and greater height. The adoption of a wider gauge in tunnels would not restrict the room for workmen, as regards trains passing; the wheels are always far inside the outside of the trains, and so they would with the 6 feet gauge, because the loads are 8 feet; the only difference would be that the two inner rails would be nearer to each other, and the two outer rails would be nearer to the walls; the centre of gravity would be the same if the loads were no higher.

An increase of the width of gauge would not render it imperative to have a corresponding increase of the radius of the curves. An increase of the gauge would not render necessary a corresponding increase of the height of the driving wheel. Does not think that in reference to the number of miles run on the broad gauge, and the number of miles run on the narrow gauge, that there are fewer accidents on the broad gauge than on the narrow. The superiority of either gauge depends not upon the gauge, but upon the condition of the permanent way. Gradients are of less importance if the road is in perfect order. Rigidity in a road is preferable to elasticity in a road. With elastic rails, it becomes like driving over a series of points. If there be any elasticity at all, it is best to have it in the whole road, like having a perfect road laid upon a bog, as in Chat Moss, or any other soft ground, where the whole railway itself could, in a very great length, have a very slight elasticity. There is less cost in the repair of Chatmoss than any other part of the Manchester and Liverpool Railway on that account. It always will be so upon soft ground. If you have a good permanent way, thick enough and strong enough in itself, and lying upon a substratum, which has a little tendency to elasticity, it is most easily kept in repair. Cross-sleepers are better than longitudinal sleepers for keeping in repair. Any sleeper of a proper form can be packed, whether it lies longitudinally or transversely. There is a greater length of bearing to be obtained upon cross-sleepers than upon longitudinal sleepers. If we were to have a railway laid from end to end, all upon cross-sleepers, there would be a much greater length of bearings than upon a railway where it is all upon longitudinal bearings; and the greater number of sleepers we have the better the road will be.

Is not aware of the exact limits of contraction and expansion, by cold and heat, of a 16-foot rail; has known the road lifted up; has known it bent sideways by expansion; has never had time or opportunity to measure it exactly; it is a difficult thing to ascertain what the expansion is in certain cases; it can be done best off the line, by ascertaining the temperature of certain lengths of bar uniformly. Expansion and contraction on longitudinal bearings have a tendency to loosen the screws which bind the rail to the balk.

Break of gauge is of little consequence in reference to passengers, but becomes a great difficulty in transferring heavy goods. It becomes a matter of importance to devise the best, cheapest, and quickest mode of transhipment from the one gauge to the other, whether it be by removing the goods from one carriage to another carriage, or by moving the body of one carriage on to another set of wheels by mechanical power; it becomes a question of cost. The measure of the inconvenience is the cost per ton to do it quickly. The expense of constructing powerful lifting machines of little importance where the traffic is large; has laid out £130,000 to save about a halfpenny per ton upon the shipping of coals. Could put up apparatus to move 25 wagons in one minute, or in a couple of minutes, requiring the employment of not less than 50, nor more than 100 men. The cost of transhipment would be a trifle upon a long line, but a large item upon a short one. It is perfectly easy to make wagon frames and wagon bodies for a large trade that would go to any part of the country; the bodies must go quite through, and return again; the frames would keep on their own lines, and the wagons would simply drop into them. There would be no difficulty in constructing passenger carriages to move in the same way; if there is traffic enough to render it worth doing, there is no difficulty in doing it.

THE HOUSES OF PARLIAMENT.

Ventilation has taken the character of stagnation in its effect upon the progress of the Houses of Parliament; more especially those parts of the interior whose completion is soonest required—at least impatiently demanded. Talking and *Reiding* have considerably retarded operations. No one room is yet anything like finished,—or much more than merely sketched out,—though the main work, that of construction in the rough, is nearly terminated in the House of Peers and the royal approach to it. At present, the picture is merely drawn in and dead-coloured; therefore we pretend not—especially from such cursory inspection as ours has been—to judge of intended effects otherwise than conjecturally, and with due submission to correction for any misunderstandings into which we may have fallen.

To begin, then, with the royal entrance from the gigantic porch beneath the Victoria Tower:—the Scala Regia, which is partly lighted by lanterns in its vaulted and groined ceiling, ascends in a direction, as seen from the entrance, turning to the right or southwards, in two successive flights. We forgot to count the number of steps in each flight, which Lord Sudely found fault with as being too many for architectural dignity. But there is a precedent for more multi stepped, and certainly for loftier, flights, in what is, perhaps, as magnificent an example of a staircase as any we know of—viz., the *Parade treppe* in Gärtner's new building of the Bibliothek at Munich. This greatly exceeds in point of amplitude, splendour, and perspective display, what the Westminster staircase promises to be. In one respect, indeed, the latter is almost unparalled,—the *risers* being unusually low, and the *treads* broad; so that what, in moderation, contributes to elegance and convenience, is here carried to such excess as to be likely to prove an incommodity. It is not only somewhat fatiguing to walk up such very shallow and broad steps, but rather difficult to do so without seeming to stride or jerk along, or making two steps of each stair. Some little practising will be necessary for either ascending or descending majestically. Passing through the *shell* of the Victoria Gallery and another room, we enter the House of Peers, at the west, or throne, end;—the first glance at its ceiling, a wide expanse of gorgeously carved and gilded work is already striking enough. How far more imposing—almost bewildering—will be the first *coup d'œil* of this spacious and magnificent hall when completed in all its decorations—its walls arrayed in gilding and emblazoning, displaying a series of compartments of fresco below, with a corresponding range of richly painted windows (six on each side) above. Still, we have our misgivings: because, though casual visitors may be more than satisfied—even enchanted—"My Lords," themselves are likely to feel sated by the constant blaze of so much architectural and pictorial pomp. Such a sumptuously, not to say extravagantly, adorned hall, would be more in place within the walls of Windsor Castle, for royal banquets and festivities, than as a place for solemn debate on grave and anxious matters. Putting propriety of purpose out of the question, we entertain great doubts, too, as to the effect which such profusion of painted glass as is intended will have upon the fresco paintings. Besides that gleams of coloured light may occasionally fall from the windows upon parts of the mural pictures, quite different in hue from the colours on the latter,—will not the windows overpower the paintings, and cause them to look flat and dull, by comparison?—or can that inconvenience be remedied by exaggerating the colours of the frescoes, and painting them up accordingly? We may be allowed also to ask, whether another matter has been taken into consideration—because if it has hitherto been forgotten or overlooked, attention should be directed to it without further delay. Will not the effect and character contemplated for the "House" be, in great measure, lost at those particular times when the place will be chiefly used for business? After dark, the painted windows will not show themselves otherwise than as gloomy gaps and vacancies, occupying the upper half of the two side walls. A singular degree of brilliancy might, however, be obtained at night, by lighting up the house chiefly, if not entirely, from without, by means of gas burners on the outside of the windows. This would be further useful as helping ventilation. The plan appears to us to have, independently of its novelty, much to recommend it; should there be objections to it, not perceived by us, we yet hope that while they have their due weight, the suggestion itself will not be wholly disregarded, merely because it is a suggestion.—*Athenæum.*

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL SCOTTISH SOCIETY OF ARTS.

June 8, 1846,—John Beatson Bell, Esq., V.P., in the Chair.

The following communications were made:—

1. *Description of the machinery used, and of the manner in which the sand at the sides and end of the open-cutting was supported during the excavating and building of the works of the Edinburgh, Leith, and Granton Railway Tunnel in Scotland Street.* By Mr. William Paterson, F.R.S.S.A., Resident Engineer of the Tunnel. In this communication, Mr. Paterson described the machinery used, and the manner in which the sand at the sides and end of the open-cutting was supported during the excavating and building of the works of the tunnel in Scotland-street. A beautiful and accurate model was at the same time exhibited, representing the face of the tunnel, and the manner of disposing the beams to resist the pressure. There were also plans and sections of the works shown. The Society were greatly interested in this communication, which was clearly illustrated by the model and drawings. Referred to a committee.

2. *Description of a Patent Crane*, by David Henderson, of Renfrew, in which the important peculiarities of his improvements will be illustrated by drawings and a working model. Mr. Slight described this patent crane, distinctly showing the important peculiarities of Mr. Henderson's improvements by the aid of drawings and a working model. One of these patent cranes is at work in Mr. Slight's own works, and the valuable invention is coming into general operation in the west. In the ordinary crane as the Derrick rises the load also rises, and much time and labour are wasted; but the relative forces of the present have been all calculated by Mr. Henderson with mathematical accuracy, so that it combines great power and efficiency with safety. The barrel and wheels are so constructed as to afford a self-acting check; that is to say, although several tons weight were suspended, and in the act of being raised or lowered, the handle of the crane can be let go at once, and the machine remains in *statu quo.* Mr. Slight pointed out several other valuable properties of this invention, the principle of which consists in the Compensation Barrel, by which after the load is raised as high as necessary, it is then brought in nearly on a level, although the Derrick be raised. This of itself saves much time and labour.

3. *Description of a Revolving Valve for Locomotive and other Steam Engines.* By John Anderson, Esq. The principles and construction of this valve are entirely new. Instead of the reciprocating or alternating motion, so long in use, Mr. Anderson adopts a continuous rotary motion. The valve may be said to consist generally of two circular metal discs, connected together by a tube, placed opposite the ports of the cylinder. These discs are divided into two chambers, the one having communication with the steam, and the other with the exit passage. Into each of these chambers ports are cut so as to form, at certain parts in the revolution of the valve, a free passage, either for the ingress or egress of the steam, the disc for the upper part being so placed that the one may be admitting steam into the cylinder while the other is allowing it to escape. The whole valve works in a cylindrical case, having ports corresponding with, and opening into, those of the cylinder, the same as that of Medhurst's, but with this important difference, that the one revolves, while the other moves in a vertical direction. The revolving valve, Mr. Anderson states, possesses the following advantages:—

1. The valve, by its continuous rotary motion, effects a great saving in power, especially in locomotive engines, where the motion is very rapid.
2. The valve is devoid of pressure, and superior in that respect to the long and short D, or slide-valves.
3. The valve creates no loss of steam in the ports, as is the case in the short D, or slide-valve.
4. The valve wears equally, and can, at a comparatively small expense, be given any length of *lap* or *lead.*
5. The valve can be easily examined and packed when required.

COLLEGE FOR CIVIL ENGINEERS, PUTNEY.

It is very gratifying to those who take an interest in the advancement of practical science to find that a sound knowledge of the exact sciences is becoming more publicly recognized as a necessary part of the education of the engineer. Compared with the stupendous public works which have been undertaken during the last few years, the greatest engineering labours of the ancient world are as nothing: and when it is reflected that the lives of thousands may probably depend on the construction of these works with a due knowledge of the mechanical sciences; it becomes a matter of direct public interest that those to whom the task is confided should possess a *systematic* knowledge of their profession. That the importance of this knowledge is becoming publicly recognized, we have a gratifying proof in the condition of the College at Putney, and the results of the recent examinations there.

We have to regret that the limits of our space will not permit, at present a detailed account of the course of the examination, and an analysis of the printed examination papers now before us. We can do little more than record the names of the students who obtained honorary distinctions, and principal circumstances of the annual meeting, which took place on the 21st June, for the distribution of these rewards. The following is the list of prize-men.

MATHEMATICS.—1st Class, Stephenson.
,, Sharp.
2nd Class, W. Clark.
3rd Class, Coghlan.

CHEMISTRY.—Laboratory Class, Newsome.
,, Ward.
1st Class, Codrington.
2nd Class, Bennett.

GENERAL CONSTRUCTION AND ARCHITECTURE.—1st Class, Stephenson.
2nd Class, W. Clark.
3rd Class, Crump.

MACHINERY.—1st Class, Drawing Prize, Male.
2nd Class, ditto, Hawsen.
Examination, Willett.

GEODESY.—Trigonometrical Surveying, Stephenson.
Ordinary Survey and Plan Drawing, Coghlan.
Ditto, 3rd Class, Christie.
Military Class, F. Davidson.
,, the Hon. P. Feilding.

MANUFACTURE OF IRON AND GENERAL PRACTICE OF MACHINERY.—Pontifex.
Descriptive Geometry, Sharp.
French, Baldry.
German, Hansen.
Landscape Drawing, F. Davidson.

The chair was taken shortly after two o'clock by the Duke of Buccleuch, who called upon the Reverend the Principal to read the report detailing the examination. Of these reports we can say no more than they must have been satisfactory to the most sanguine supporters of the Institution. The certificates for prizes were given by the noble chairman to the students as their names were successively mentioned in the Reports.

The noble Chairman in the course of his address showed in very clear terms the fallacy of the notion that mere professional "experience," unguided by preliminary systematic education, was sufficient for the purposes of the engineer. He argued that modern engineering had made such advances and was now frequently applied to purposes so perfectly new and unprecedented, that cases must continually occur where the "rule of thumb," as it was called, would be of no avail. He took occasion also to compliment Mr. Cowie on the successful issue of his labous.

The Bishop of London, in his usual felicitous manner, eulogised the moral and gentlemanly deportment of the students. From living in the vicinity he had taken great interest in this subject, and had uniformly found that his neighbours concurred with him in giving the college this merit. Their testimony was of the greatest value because founded on impartial personal observation.

The Earl of Devon proposed and Sir Charles Lemon seconded a vote of thanks to the Duke of Buccleuch. Sir Charles Lemon observed that the enlightened sentiments of the Duke had never been more conspicuous than in his zealous support of the College, and his talents had never been better exhibited than in the clear views which his address contained of the results of the system pursued in the education of the students.

The following were among the noblemen and gentlemen present:—Duke of Buccleuch in the chair; Bishop of London; Earl of Devon; Earl of Denbigh; Sir C. Lemon, M.P.; Sir J. Duckworth, M.P.; Hon. R. Howard; E. Antrobus, Esq., M.P.; the Right Hon. the Lord Mayor; Major Olephant; Gen. H. Thompson; Col. Sykes; Capt. Moorsom; Col. Devereux; Dr. Arnott; J. C. Whiteman, Esq. Mr. Walker and Mr. Cubitt had both promised to attend, unless prevented by urgent business, and the Bishop of Oxford sent a letter regretting that buisness prevented his presence at the College.

A NEW THEORY ON THE STRENGTH AND STRESS OF MATERIALS.

SIR—Although I did not intend to answer queries, or discuss differences respecting the theory of the strength of materials, which I am advancing, until I should have the whole developed, yet I think it my duty to stop and more fully explain one or two points to which you have alluded in your last number. My theory is not founded on the idea, "that there does not exist in deflected beams what is termed a NEUTRAL LINE," yet I deny the existence of a *neutral* line, or a *neutral surface* as some writers term it. Your definition of the neutral line differs a little from that given by Barlow, Tredgold, Moseley, &c.; be good enough to look at Tredgold's definition again, I gave it in my first article. Moseley says, "One surface of a beam becoming, when deflected, convex, and the other concave, it is evident that the material forming that side of the beam which is bounded by the one surface is, in the act of flexure, extended, and the other compressed. The surface which separates these two portions of the material being that where its extension terminates and its compression begins, and which sustains, therefore, neither extension nor compression, is called the *neutral surface.*" If you look you will find that your definition of the neutral line differs a little from this also. You say that "the originators of the term *neutral line* stated that when a horizontal beam supports a transverse weight, the upper part of the beam exerts a thrust and the lower part a tension; and since these two portions of the beam exert opposite kinds of action, there must be in the beam some intermediate part which marks the transition from one state to the other—where, therefore, there is neither thrust nor tension." Now this is the truth, but not the whole truth; consider two sections in a beam deflected by a weight, one in the centre and the other anywhere between that and one of the supports; the compressions and extensions in these sections will differ in intensity, and if we suppose a fibre whose breadth is very small, dx, *if you please*, I say that the state of neutrality of this fibre, at one of these sections, differs in degree from that at the other, without reference to the action which increases or endeavours to increase the thickness of the beam at top and decreases it at the lower part, which action has been neglected by every writer on the subject. For argument sake, let the line which separates the thrusts and tensions of every section be a mathematical line, then the only change that can take place in this line is in its length and deflection; then ask yourself the question, as the beam becomes loaded, is not this neutral line, under one amount of pressure, longer and more deflected than under any less amount. However, my great difference with other writers is not about the neutral line or surface. Other writers might have established their theory independent of the thickness of the beam, for they state that no action takes place in the direction of the breadth, that is, in the direction of your axis of Z. I show that there does exist an action in the direction of Z. I say that if a body becomes extended, or compressed, its cross sectional area is diminished, or increased, or has a tendency to diminish or increase, although the cross sections present similar figures: I am now speaking of the elongation of bars suspended vertically, and sustaining a given strain in the direction of their length. Other writers go so far as to suppose that the cross section remains the same till the body be extended to twice its length;—of this matter I will speak by-and-by.

When you refer to fig. 3 of my last article, page 104, "he says," speaking of me, "that if a beam be deflected and a *slice taken from the upper part* of it, this slice has the same form as the whole beam, and consequently there is as much reason for assigning a neutral line to the slice as to the whole beam." You will find that I did not take a slice from the upper part, and that I said, "the same process of reasoning which points out a neutral axis in the whole, will point out a neutral axis in any portion of the body, no matter where it is situated." In this instance you will find that I attacked the reasoning employed by others. Lower down it is said, "For when he says that the form of the *thin upper slice* is an argument for the existence of a neutral in it, he makes the neutral depend merely on the form of the beam and not on the mechanical action of its parts." You will find that I said no such thing, nor made use of no such argument; what I said I will repeat; it follows immediately what I quoted above,—"in fact, every fibre may be said to be compressed on one side and extended at the other, while the whole or each is bent round a common centre, entirely outside the body." When I select a portion I do not take an upper slice, for I say, "Now let us take $gcdxtyqz$ (fig. 3, page 104), any portion of the beam, it is evident that the filaments in the upper part near dtq are expanded, and those near to xyz are compressed;" mark what I say,—"according to this reasoning there is a set of fibres between dtq and xyz which are neither compressed nor expanded; *hence*, each portion of the beam is entitled to a neutral axis, *which is relatively correct*, but each neutral axis is itself bent round a centre." I hope you do not mean to say "that the form of the beam is not influenced by the mechanical action and connection of its parts," for I think that it will not be denied that the mechanical action is influenced by the form, and also that the form is influenced by the mechanical action. I have got to the place where you say, "We proceed now to the direct arguments establishing the actual existence of the neutral boundary." Neutral with respect to what? Neutral with respect to thrust and tension? Neutral with respect to what degree of thrust and tension? You might as well try to upset the truths of the multiplication table as $\Sigma(X) = 0$, $\Sigma(Y) + R - \frac{1}{2}W = 0$, $\Sigma(Z) = 0$; and you might as well try to understand what the author of the work on the "Calculus," published by the Society for the Diffusion of Useful Knowledge, means when he describes the third differential coefficient, as to try to understand what writers on this subject mean by such terms as "the internal forces of the beam," "the molecular action of the forces in the cross section," &c.; or, in other words, the equations have never been satisfied. If $R = \frac{1}{2}W$, it is evident that $\Sigma(Y) = 0$, but how is $\Sigma(Y)$ made up? This would be of no consequence, only the thrusts and tensions of $\Sigma(X)$ are uninfluenced by it. You, or rather the writer of the article in question, having despatched $\Sigma(Y)$, says, "similar reasoning applies to the forces represented by $\Sigma(Z)$"; now this assertion is not correct. I have before stated (page 105, fig. 11) the nature of the action of the particles in the direction of the axis of Z, so I need not dwell upon the matter here; and although $\Sigma(X) = 0$ may be represented by the statical couple $+M, -M$, little is known with respect to their actual amount, and as the distance between their points of application vary, your equations

$Mb = \frac{1}{2}Wa$, although true, leaves us in the very same difficulty as $\Sigma(X) = 0$. As b is variable, it would have been better to have said $My = \frac{1}{2}Wa$. Indeed, in taking moments about A (fig. 2, p. 205), it would be as well to call the perpendicular let fall from A, on the direction of $+M$, x; and the perpendicular on the direction of $-M$, x'; then, $+M \times x$ added to $-M \times x' = M(x-x') = \frac{1}{2}Wa$; this supposes both forces to be directed at the same side of A; however, if one acts above and the other below, then we have $M(x+x') = \frac{1}{2}Wa$, but in both cases, the quantities between the brackets is the distance between the points of application of the forces. At first sight, the equation My, or Mb, or $M(x+x')$, or $M(x-x')$, $= \frac{1}{2}Wa$ would appear to involve but one unknown quantity; but it involves two, for there is as little known about M as there is about y. I cannot see for what purpose these equations were introduced, except to show, if we were able to do it, how the principles of statics might be applied to the problem under consideration; however, I can see no connection between them and what follows, but perhaps others may.

The next four paragraphs, beginning with "We have, therefore, the upper and lower parts of C D in &c.," at the bottom of the first column, page 205, contains very little more than different methods of stating the same thing, or some general expressions that would be true in almost any inquiry, such as, "We are, therefore, perfectly safe in supposing that there is some general law by which these variations of action may be represented, that is, that the amount of molecular force at any point of either side of the beam is a continuous function of the distance from some fixed point." You must not be offended, for I am now speaking plainly; to beat round the bush would take up too much space. Lower down, where you come to the conclusion, "Consequently there is no longitudinal action whatever at the neutral boundary." If you reflect for a moment, you must admit that this boundary might be elongated, for it is only capable of being elongated and deflected, without altering the thrusts or tensions, except with respect to their intensity, of which there is but little known.

For the present, I beg you will excuse these few remarks, hastily made, until I have developed the whole of my Theory, then I will be glad to enter into any explanation that may be required.

I am, Sir, yours obediently,

Oliver Byrne.

NOTES OF THE MONTH.

Wellington Memorial.—The newspapers announce the gratifying intelligence that, in consequence of a discussion in the House of Commons, the preparations for raising the statue of the Duke of Wellington to the top of the triumphal arch in Piccadilly will be discontinued.

Fitzwilliam Museum, Cambridge.—We learn also with great pleasure that Mr. Cockerell has obtained power to deviate from the original plan for completing the Fitzwilliam Museum, by substituting real marble for imitation marble in the internal decorations.

Jesus College Chapel.—Among the contemplated alterations is the substitution of an arcade of five lancets (according to the original plan) for the present Perpendicular window. A Norman triplet in the north transept will be displayed. The choir had formerly aisles extending as far as the present lancet windows; the northern aisles will be rebuilt. We are not quite reconciled to the destruction of any of the genuine architecture, but the restoration is superintended by Mr. Salvin, and is therefore in safe hands.

Ely Cathedral.—The restoration advances rapidly. All the plaster work is being ruthlessly destroyed. The great tower is opened to the second story. Two painted windows by Mr. Wailes have been completed. A painted window will be inserted in the lanthern at the expense of the members of the University of Cambridge *in statu puppillari*.

The French Minister of Public Instruction has informed the Ecclesiological, late Cambridge Camden Society, that a complete set of the works of the Comité Historique is placed at the disposal of the Society.

Standon, Herts.—A new Decorated church has been erected from the designs of Mr. Salvin.

St. Bartholomew's, Nettlebed, is being rebuilt by Mr. Hakewill.

Seamen's Church, St. Katherine's Dock.—This church, which will hold 800 persons, is in the Early English style. The design appears to be exceedingly faulty.

St. James's Church, Westminster.—A new east window has been painted for this church by Mr. Wailes. The colours are very brilliant and the jointing of the glass is managed so skilfully as to be scarcely seen from the interior of the church; but the designs have an appearance of confusion and the drawing is not very correct. Of course we need not state our opinion respecting the use of Corinthian columns as mullions, as in the case of this window. Among the decorations or desecrations is the painting of parts of the walls in imitation of marble.

Architecture in Edinburgh.—The *Scotsman* speaks highly of the architecture of the New Commercial Bank, from which the scaffolding is partially removed. The design and also the sculpture is by Mr. James Wyatt.

There is a project under consideration for connecting all Natural History Societies with the Linnæan. The latter will be the principal Society, and the others will be considered as sections.

M. Hallette, whose inventions connected with atmospheric railways have been described in this Journal and are now being experimented upon at Peckham, recently died at Arras. He was an eminent builder of locomotive engines.

The third centenary of the birthday of the Danish astronomer, Tycho Brahé, was celebrated on the 21st of June by the erection of a monumental bust under a triumphal arch on the little island of Hveen, his birthplace.

The second centenary of the death of Leibnitz has been celebrated with great pomp by his *alma mater*, the University of Leipsig.

At Paris, the Chamber of Deputies has voted £41,000 for purchasing ground required for the purposes of the Museum of Natural History.

The new papal government have withdrawn the old prohibition against the construction of railways in the papal dominions.

Painting on Lava.—This new process seems to be one of considerable importance as a substitute for enamel painting, on account of the large size of which the pieces of lava can be obtained. A large historical picture, painted on four plates of lava, which together have a surface equivalent to 10 feet square, has been completed for the church St. Vincent-de-Paul, at Paris. The advantage of lava for this purpose is, that being vitrious it receives vitrifiable colours without changing its form in baking.

The restoration of Malvern Abbey is completed.

The figures on the great gate of the cathedral of Senlis have been restored by M. Rabinet, sculptor, under the direction of the architect, M. Ramée.

The French Chamber of Deputies have voted a sum of money for the publication of the work by MM. Cotta and Flandin on the ruins of Nineveh.

It has been suggested that the fields north of the Model Prison at Pentonville should be converted into a park. This, if done at all, must be quickly; otherwise, there is every reason to suppose, from the rapid increase of buildings in this neighbourhood, that the ground will be soon built upon. A park in this locality, which is far removed from any of the existing "lungs of the metropolis," would be an incalculable benefit to the poor inhabitants.

Electric Clocks.—By means of the electric telegraph on the Edinburgh and Glasgow Railway, Mr. Bain has exhibited a clock of which the pendulum at Glasgow regulated the movement of the dial-wheels and hands at Edinburgh!

The *Presbyterian Church*, in Lower Gloucester-street, Dublin, has recently been completed, from the designs of Mr. D. Ferguson, a young and rising architect. This building is the first in the Grecian Doric order that has been erected in Dublin, with fine Irish granite, and the execution is highly creditable for a first attempt of the workmen. The Acroteria are perfectly new in this country, and have a very pleasing effect upon pediments too small for the support of statues. The lighting of this church is effected by a most economical plan, costing not more than half the expense of lighting in the usual manner with pillars and brackets. Mr. Ferguson holds the Mastership of the Architectural School of the Royal Dublin Society.

An Institute going a begging.—Under this title the *Athenæum* alludes to a circular issued by the Institute of British Architects, soliciting architectural essays from men of erudition and science. The paper in the *Athenæum* contains some valuable suggestions, to which we must refer next month.

Comparison of the economic properties of coals.—A most important series of experiments is about to be undertaken at the College for Civil Engineers, Putney, on the part of the Admiralty, in order to a comparison of the relative evaporative powers and facility of combustion of different kinds of coals. The examination will be conducted by Sir Henry de la Beche and Dr. Lyon Playfair. A enormous mass of information on the same subject is contained in a report published by order of the American Congress, which was noticed in our last volume, p. 242.

The French Geological Society meet at Alais on the 14th of September.

St. Mary's Church, Kidderminster, is to be restored, at a cost of £2,000.

The Isthmus of Panama Railway will be commenced, it is said, next November.

The Hungerford Bridge Terminus of the Southampton Railway.—Several houses are being cleared away for the construction of the viaduct from the Nine Elms station.

Bridge over the Mersey at Runcorn.—The Admiralty requires that the arches shall have a clear headway under their centres of 100 feet, and a waterway between the piers of 280 feet. If flat girders be substituted for arches, 250 feet between the piers will be sufficient.

British Museum.—Sir R. Inglis has stated in the House of Commons, that the works will be completed in three years time.

Geology.—A very curious theory has been propounded by Commander Morton respecting the columns at Giant's Causeway and Staffa. He asserts that molten lava in crystallising could never form blocks fitting into each other with sockets or joints; and that, consequently, the usual opinion that the columns in question are formed from molten basalt is untenable. He asserts that they are *petrified forests of gigantic bamboos*; and refers to the well-known fact that bamboos and canes, when growing, secrete silex. The divisions in the basaltic columns resemble in form and position the joints of growing bamboos.

Professor Donaldson invited all the principal members of the Architectural profession to a soiree at his house at Bolton-gardens, Russell-square, on Tuesday, 7th ult.; it was well attended, Several works of art were laid on the tables, and a sumptuous entertainment provided at the close.

Westminster Bridge.—It is reported that Mr. Walker and the committee have had several consultations respecting the condition of Westminster-bridge, and the general opinion entertained by them is that the present structure should be pulled down and a new one substituted. Mr. Walker has already drawn out plans and specifications for the new bridge. He proposes that a temporary wooden bridge should be erected, and the new bridge commence eastward of Ginger's Hotel.

Substitute for Gunpowder.—Professor Schonbrin has just presented to the Society of Natural History, Basle, a specimen of cotton prepared by him which is more inflammable than gunpowder, and explodes within a capsule. Several trials have been made of it, from which it appears that a small quantity, equal to the sixteenth part of an ounce, placed in a gun, projected the ball with such force that it perforated two planks at a distance of fifty-eight paces, and at another time, with the same charge and at the same distance, drove a ball into a wall to the depth of nearly four inches.

Coloured Glass.—Mr. Hoadly, of the Hampstead Road, has shown us several patterns of a new description of coloured glass borders which possess considerable elegance, and can be produced at a very moderate price, a handsome border with a ruby or blue ground and a silver and gold embossed ornament can be sold at 5s. 6d. per foot, and a ruby blue or gold ground with silver or white embossed ornament at 2s. to 4s. per foot.

Fortifications at Sheerness.—The new works continue to progress slowly and steadily. The scarp of the battery forming opposite the Dockyard gate is now being proceeded with. The musketry walls connecting it to the old works of Garrison Point on the one hand, and to the line of bastions extending from the Thames to the Medway in the other, are well nigh completed. Each wall is upwards of 120 yards in length, three feet thick, from 10 to 12 feet in height, and has loop-holes for musketry at every three and a half feet distance. A ditch 50 feet wide, and 15 feet deep, is to surround the battery. It is almost formed, and will communicate with that from the Medway, which is to be cleared out and deepened, and the bastions extending along it are to be heightened with the mud procured by the excavation. The following guns have been ordered for the new works: One 56-pounder, 97 cwt., 11 feet long, 17 eight-inch guns 65 cwt. each, 9 feet long—28 32-pounders, 56 cwt. each, 9 feet long—and 12 24-pounders of 20 cwt. each, 6 feet long—total, 58. The 24-pounders will be mounted on iron carriages, but all the heavier guns on wooden carriages with traversing platforms. Sixty-three guns of a similar description have already been received, and are to be mounted on the old works surrounding the garrison. The alterations and repairs there are progressing favourably, the pivots and tramways for the traversing platforms of all the 32-pounders being already laid down; the parapet has also been heightened along its whole extent. One or two companies of artillery are to be in future permanently stationed here, and new and extensive barracks are to be erected for their accommodation, the present being confined and incapable of accommodating more than 300 men, which is the average number of troops forming this garrison.

THE BASILICA AT ROME.

The *Times* correspondent of Rome gives us the following description of the Basilica:—The Basilic is the metropolitan of Rome. The original structure was commenced ten centuries ago, but the building was twice burnt down, and the Basilic, as it now stands, was begun in 1368. Several Popes, including Clement V., Urban V., Alexander VI., Pius IV., Sixtus V., and Clement XII., lavished enormous sums of money on it, so that, although the proportions are not so vast as St. Peter's, it is almost equal in magnificence, and certainly far superior to all other churches of the Eternal City. Severe taste will, however, condemn the gilded roof, though by the crowd it is very much admired; but where mosaic marble, painting and sculpture abound, the meretricious ornament of gilding should not be introduced. The bijou of the cathedral is the Chapel Corsini; it is perfection, and within that little space there is more to be found to satisfy the eye and exalt the mind than in any other part of the immense pile of buildings. The altar-piece is a mosaic, copied from a picture by Guido, executed with so much delicacy that you almost desire to touch the work to be convinced that it is not a painting. The bronze statue of Clement XII. is also admirable. The expression of the face is perfect; and every line traced by care and age is reproduced with the fidelity of nature. There are two groups of marble in the niches at each side of the bronze statue by Monaldi, on which it is said Canova studied intensely. There is a female figure in one which is almost the model of his Venus, but the neck, bust, and arm are far superior to anything that Canova ever produced. The mosaic floor is very remarkable, as well as the precious marbles, which are used with an unsparing hand; but the wonder of the place is a subterranean chapel, where the tombs of the Corsini family abound, and where a marble group of the Virgin and dead Christ are not inappropriately placed. Bernini is given as the sculptor's name, but I imagine that much of the fame which the group has acquired is owing to the purity of the material, which admits a little of trick in the exhibition, and to the place where it is situated disposing the mind to religious meditation. The man who shows the statue does so by the light of a small wax taper, and as he passes the light along the lifeless body of our Saviour it appears to be wax, not marble. The hands are positively transparent. The agony of life in the Virgin is finely contrasted with the inert weight of the corpse which hangs from her embrace; but I believe that the group, however beautiful, would lose much of its value if exposed to the open day. The late Count Somariva, at Paris, used to show Canova's Magdalen in the same manner; but good judges condemned him, as the eye never embraced the whole figure, but was carried from one littleness, such as the graining of the skin, which Canova introduced, to another. There is a chill of death in the subterranean chapel of the Corsini, and the sacristan who shows it not only covers his own head, but carefully recommends you to do the same. The ceremony at St. John de Lateran was limited to the celebration of mass, and the Pope returned to the Quirinal in the same simple manner that he left it.

THE CHANNEL SQUADRON—TRIAL OF STEAMERS.

On the 30th June, the steamers were ordered to try rate of steaming. At 10 a.m. the Retribution, Gladiator, and Avenger, started, full power, with a strong breeze six points on port bow. In two hours the Retribution gained on Gladiator 1¼ miles; on Avenger three miles. At noon altered course to wind on port beam, and tried until 4 p.m.—at each successive step of expansion gear—during the whole of this time the relative distances were perceived as near as possible as during the trial from 10 to 12. At 4, being about seven or eight miles dead to leeward of the Admiral the signal was made to prepare to steam to windward. Topmasts were in consequence struck, and everything got ready to join the ships to windward. At about 4·30 they started abreast. Retribution soon got the lead, although Gladiator stuck very close for a few minutes; but once clear of her, she soon shot ahead, beating her in the run about two miles, and Avenger four miles.

Gladiator and Avenger were each working up to 10 lb. the square inch, having tubular boilers Retribution can only work up to 6 lb., having the old common boilers.

July 1.—The Terrible having joined the fleet during the previous night, a signal was made to try rate of steaming with her. They accordingly started at about 10 a.m., with full power, the Terrible, with her tubular boilers, working up to 13 lb. the square-inch, and after steaming dead to windward, with a strong breese and heavy head-swell for three hours, she beat Retribution as near as possible half a mile an hour. Unquestionably she is a noble ship; but, nevertheless, I am inclined to believe she beat Retribution principally by the great command of steam generated by tubular boilers. Had both ships been fitted with similar boilers, probably the result would have been different. One thing by this trial appears to be clearly settled—that where two ships of similar tonnage, or nearly so, and equal horse power, but fitted with tubular and common boilers, are matched, the former must have the advantage in speed over the latter. This was very evident in the trial the day before with Gladiator, for with Retribution's immense engines of 800 horse power, over Gladiator's 450, the former certainly ought to have beat her double the distance, had they both been fitted with similarly constructed boilers. At 1 p.m. a signal was made to Terrible to steam with 6 lb. pressure only. At first Retribution gained rapidly on her, but as soon as this was perceived on board she shot ahead again. In short, this trial is not worth relating, it being almost impossible to keep steam at any exact pressure. A few shovelsful of coal, or slightest alteration of throttle valve, more or less, will always cause an alteration. In the evening they both banked the fires.

July 2, at 9 a.m., we tried rate of sailing on the wind, starboard tack. Terrible, under all plain sail; Retribution, with single-reefed topsails. At 11, the wind falling light, Retribution shook out first reefs. At 1·30 p.m., Retribution being about one mile ahead, tacked. At 3, having weathered on her opponent about three quarters of a mile, bore up and set port studding sails. Ran until sunset without any difference of sailing; then lighted the fires of two boilers and steamed all night. Terrible gained two miles all night. Arrived at Cove this evening, July 3, at 7 p.m. Found the squadron lying there.

MISCELLANEA.

Sculpture Machine.—During a recent visit in Boston we were shown specimens of the production of a wonderful piece of mechanism, which were, indeed, truly astonishing. They were miniature busts of Daniel Webster, Abtot Lawrence, and Levi Woodbury; being perfect facsimiles of their distinguished originals, and wrought out of beautiful American marble, and by a machine which has been invented by Mr. Thomas Blanchard, of Boston. This invention certainly establishes a new era in the art of sculpture, and promises to dispense almost entirely with the deep thought, and classic study, and indefatigable labour of the artist, in his efforts to put life and poetry into the marble, for nature, art, every thing tangible, can be copied by this machine, with a precision which defies the chisel, even when guided by the most skilful hand and directed by the most gifted talent. The machine, too, can be graduated so as to give reduced copies of any statuary, which shall, in their miniature, be perfect and exact copies of the originals in everything else but size; preserving every line, furrow, and dimple, and giving prominence to muscles and veins, and every particular lineament and feature, in exact proportion. By the same machinery, the most correct and perfect bas-relief profile likenesses may be cut, on the hardest material, and of any size required, from half an inch to full life-like size. We saw a strikingly exact cameo profile of Henry Clay, as perfect a head of that statesman as we have ever seen in any of the busts or casts to be found, and of the fashionable size for a lady's breast-pin. Among the specimens shown us, too, were the heads of several of our acquaintances, cut in cameo and ivory, the proper size for setting in pins, the first glimpse of which called before our minds the originals as readily as the most perfect daguerreotype or pencilled miniature would have done. We are assured that the best of Greenough's and Pera'co's productions, which have cost them years of study and effort, can be copied by this apparatus with most positive accuracy; and the block of shapeless marble put into its power will, in a few hours, stand forth a perfect copy of the most beautiful and animated statuary the greatest sculptors ever produced. And, what is most wonderful, this machinery may be readily graduated to increase or diminish the copy, so as to furnish a colossal or a miniature figure, with equal precision, and in all respects exact proportions.—"American paper."

Alligator Oil.—A letter from St. Augustine, dated April 12, says:—"I suppose that you may not have heard that we have discovered the utility of alligators. An alligator is found to be as valuable in his way as a spermaceti whale. An expedition has left this place for the river of St. John's, and the dark tributary stream of Black Creek, swarming with these hideous creatures, with the view of killing them to obtain their oil. The oil of the alligator is said to be better for lamps than even whale oil, and it is extracted from the animal in considerable quantity and without any great difficulty. For this discovery we are indebted to the Indians, who have been in the habit, for how long a time I know not, of extracting the oil of the alligator and using it for various purposes. It makes a fine transparent fluid and burns admirably. You know how many of these enormous animals are shot out of wantonness from the decks of the steamboats that plough our waters. I expect he eafter to hear of laws passed for their protection. Every time an alligator of 18 feet long is shot in the long grass of the river banks, or while he is swimming, a barrel or half a barrel of oil, as the case may be, is wasted. This should not be. We must allow them to be killed only at a proper season, when they are fattest, and not permit their destruction at the season when they lay their eggs. The alligator is a formidable looking creature, it is true, but he is generally harmless. His office is to prowl in the sluggish waters of this southern region, pick up what he can, and digest it into excellent oil for the illumination of our houses. Alligators will be hereafter esteemed as useful animals as pigs—perhaps more so, for their keeping costs nothing. The danger is, that now that the world has discovered what they are good for, their race will be exterminated."—'Montreal Times.'

Mammoth Locomotives.—The Great Western have just completed three most powerful locomotive engines, built upon the plan and under the superintendence of Mr. Brunel, assisted by Mr. Gooch, the superintendent of the locomotive department. The dimensions of the Great Western engine (the leviathan of locomotives) are as follows:—Diameter of driving wheel 8 feet; cylinder, 18 inches; stroke, 24 inches; boiler, between 15 and 16 feet; weight of engine, 36 tons, without water; weight of the tender, without either coke or water, 10 tons; making a total of 46 tons. This splendid engine, built for passenger trains, drew a train weighing 136 tons up the incline at Wootton Bassett, with as much ease and as fast as one of the smaller engines would a passenger train. The engine Queen is likewise for passenger trains, and was built at Swindon: Driving wheels, 7 feet diameter; stroke, 18 inches; cylinder, 16 inches; boiler, 14 feet; weight of engine, without water, 25 tons; weight of tender, 9 tons, without coke or water. The above engines, when their machinery get into perfect order, are intended to be employed in propelling the express trains. The other is a luggage engine, the Premier, having her six wheels of 5 feet diameter connected. The dimensions of this locomotive are in other respects similar to the Great Western passenger engine. The Premier is decidedly the most powerful employed on the broad gauge, surpassing in strength and speed the Hercules engine, which propelled 406 tons on the experimental trip with the gauge commissioners.—A new and powerful locomotive, the Goliah, was lately tried on the Sheffield, Ashton-under-Lyne, and Manchester Railway. It is the largest crank-axle locomotive engine ever built. The cylinders are 18 inches in diameter, with two feet stroke, mounted on six wheels of four feet six inches in diameter, all coupled, so that they will not be liable to slip in wet weather, or with a heavy load, as is often the case with those constructed upon the present principle. The engine is calculated to take a load of upwards of 1,000 tons, on a level, at the rate of 20 miles an hour. It has given every satisfaction to the company, who have nine more engines of a similar description in progress of building at the works of Messrs. Sharp, Roberts and Co.

LIST OF NEW PATENTS.

(From Messrs. Robertson's List.)

GRANTED IN ENGLAND FROM JUNE 27, 1846, TO JULY 23, 1846.

Six Months allowed for Enrolment, unless otherwise expressed.

Joseph Storer, of Stanhope street, Mornington crescent, musical instrument maker, for "Improvements in organs, seraphines, and other free reed instruments, part of which instruments are applicable to piano fortes." (A communication.)—June 27.

John Davie Morris Stirling, of Black Range, North Britain, esq., for "certain new alloys and metallic compounds with a method of welding the same and other metals."—June 29.

Francois Stanilas Meldon de Sussex, of Millwall, Middlesex, manufacturing chemist, for "Improvements in the manufacture of soda and potash."—June 29.

Thomas Lane Coulson, of Assington Hall, Assington, Suffolk, esq., for "Improvements in the construction of chairs."—June 29.

Charles Payne, of Whitehall wharf, Cannon row, Westminster, gentleman, for "Improvements in preserving vegetable matter."—June 29.

William Mill, of Newhall street, Birmingham, manufacturer, for "Improvements in instruments used for writing and marking, and in the construction of inkstands."—June 29.

Moses Poole, of London, gentleman, for "Improvements in regulating the velocity of steam engines." (A communication.)—June 29.

Joseph Moreland, of Old-street, Middlesex, copper still and boiler setter, oven builder, constructer and designer of furnaces generally, for "Improvements in setting and fixing coppers, stills, and boilers, and in the construction of fur aces."—June 29.

William Smith, of the city of London, gas meter manufacturer, for "certain Improvements in gas meters."—June 29.

Anto'ne Perpigna, of Paris, advocate, for "Improvements in regulators for qualifying the actions of mechanical powers." (A communication.)—June 29.

John Tatham, of Rochdale, Lancaster, machine maker, David Cheetham, of the same place, machine maker, and John Wallace Duncan, of Manchester, gentleman, for "certain Improvements in machinery or apparatus, to be used in the preparation and spinning of cotton and other fibrous substances."—June 29.

Joseph Seraphin Faucon, of Rouen, in France, banker, for "Improvements in combining materials to be employed in fulling cloth."—June 29.

Sir James Caleb Anderson, of Buttevant castle, Ireland, baronet, for "certain Improvements in obtaining motive power, and in applying it to propel carriages and vessels, and to the driving of machinery."—June 29.

Thomas Parkin, of Hoxton, in the county of Middlesex, engineer, for "Improvements in the means of giving motion to locomotive carriages, with or without bearing wheels attached to them, and in the construction of ways, passages, and roads, on which the said carriages are to travel."—June 29.

Charles Clark, of Cornhill, City, merchant, for "certain Improvements in the pyro-hydro-pneumatic apparatus for generating, purifying, and condensing, steam and other vapours, and for obtaining vegetable extracts."—June 29.

James Hastings, of Havre, in France, for "an Improved machine for making bricks, tiles, quarries, and cornice ornaments."—June 30.

William Clarke, of Hoxton, Middlesex, machinist, for "certain Improvements in weighing machines, steel yards, and scale beams."—June 30.

James Thompson, of Liverpool, engineer, for "certain Improvements in machinery or apparatus for obtained motive power, part or parts of which improvements are applicable to other useful purposes."—July 6.

Peter Ward, of Oldbury, county of Worcester, chemical manager, for "Improvements in the manufacture of certain salts of soda and magnesia."—July 6.

Richard Wright, of Hermitage-terrace, in the parish of Bow, sugar refiner, for "Improvements in refining sugar."—July 6.

George Downing, of Birmingham, steel pen tool maker, for "a certain Improvement in the manufacture of penholders."—July 6.

Frederick Ransome, of Ipswich, engineer, and John Crabb Blair Warren, Little Horksley, Essex, clerk, for "certain Improvements in the manufacture of bricks, tiles, pipes, and other articles composed of plastic materials, and in the preparation of plastic materials to be used for such purposes."—July 6.

John Palmer De la Fons, of Carlton-hill, St. John's Wood, in the county of Middlesex, Esq., for "Improvements in the manufacture of locks and other fastenings"—July 6.

William M'Gary, of Hoxton, Middlesex, for "Improvements in lamps, lamp glasses, candles, and shades."—July 6.

Thomas Woolley, of Nottingham, piano forte manufacturer, for "Improvements in piano fortes."—July 8.

Robert Beart, of Godmanchester, in the county of Huntingdon, farmer, for "Improvements in tiling land."—July 10.

William Middlemore, of Birmingham, manufacturer, for "a certain Improvement, or certain improvements in saddles."—July 13.

William Seed, of Preston, Lancaster, machine maker, for "certain Improvements in machinery or apparatus for preparing, slubbing, and roving cotton, and other fibrous substances."—July 14.

George Knight, of Southampton, wine merchant, for "certain Improvements in excavating and dredging; also in the formation of permanent and temporary harbours, canals, bridges, docks, and other similar works, and in the apparatus to be employed therein."—July 14.

Odert Gripenberg, of Finland, Russia for "Improvements in machinery for sowing grain and other seed."—July 14.

William Watson Pattinson, of Felling, near Gateshead, Durham, manufacturing chemist, for "Improvements in the manufacture of chlorine."—July 14.

Charles Frederick Bielefeld, of Wellington-street, Strand, papier maché manufacturer, for "Improvements in the making of moulds or dies used in the manufacture of papier maché, and other matters, and in moulding or forming articles from certain plastic materials."—July 14.

Gustaf Victor Gustafsson, late of Sweden, but now of Warren-street, Fitzroy-square, engineer, for "certain Improvements in steam engines."—July 14.

Lawrence Hill, jun., of Glasgow, civil and mechanical engineer, "for Improvements in the manufacture of iron for building ships and boats, and other vessels; and in the construction of ships and boats, and other vessels; and in instruments, machinery, and apparatus to be used in the said construction. (A communication.)—July 14.

Sir Samuel Brown, Knight of the Hanoverian Guelphic Order, and Captain in our Navy, of Blackheath, for "Improvements in railways and carriages to run on railways, and in the construction and arming ships or vessels."—July 14.

David Yoolow Stewart, of Montrose, Scotland, for "Improvements in moulding iron and brass."—July 14.

Thomas Symes Prideaux, of Southampton, gentleman, for "Improvements in machinery for excavating."—July 15.

William Thomas, of Cheapside, London, merchant, for "certain Improvements in frames, locks, and fastenings for carpet-bags and purses, parts of said improvements being applicable to all other locks."—July 15; two months.

Thomas Bouser, of Merton, Surrey, and Edwin Walker Williams [illegible] Pettit, of York-road, Lambeth, civil engineer, for "certain Improvements in machinery for tilling land."—July 15.

William Shurman, of the town and county of Nottingham, hosier, for "certain Improvements in the manufacture of gloves, stockings, and other hosiery goods."—July 15.

James Napier, of Shacklewell, in the county of Middlesex, operative chemist, for "Improvements in smelting copper ores."—July 20.

John Boyes, of Mincing-lane, gentleman, for "Improvements in machinery for thrashing and winnowing grain and seeds."—July 23.

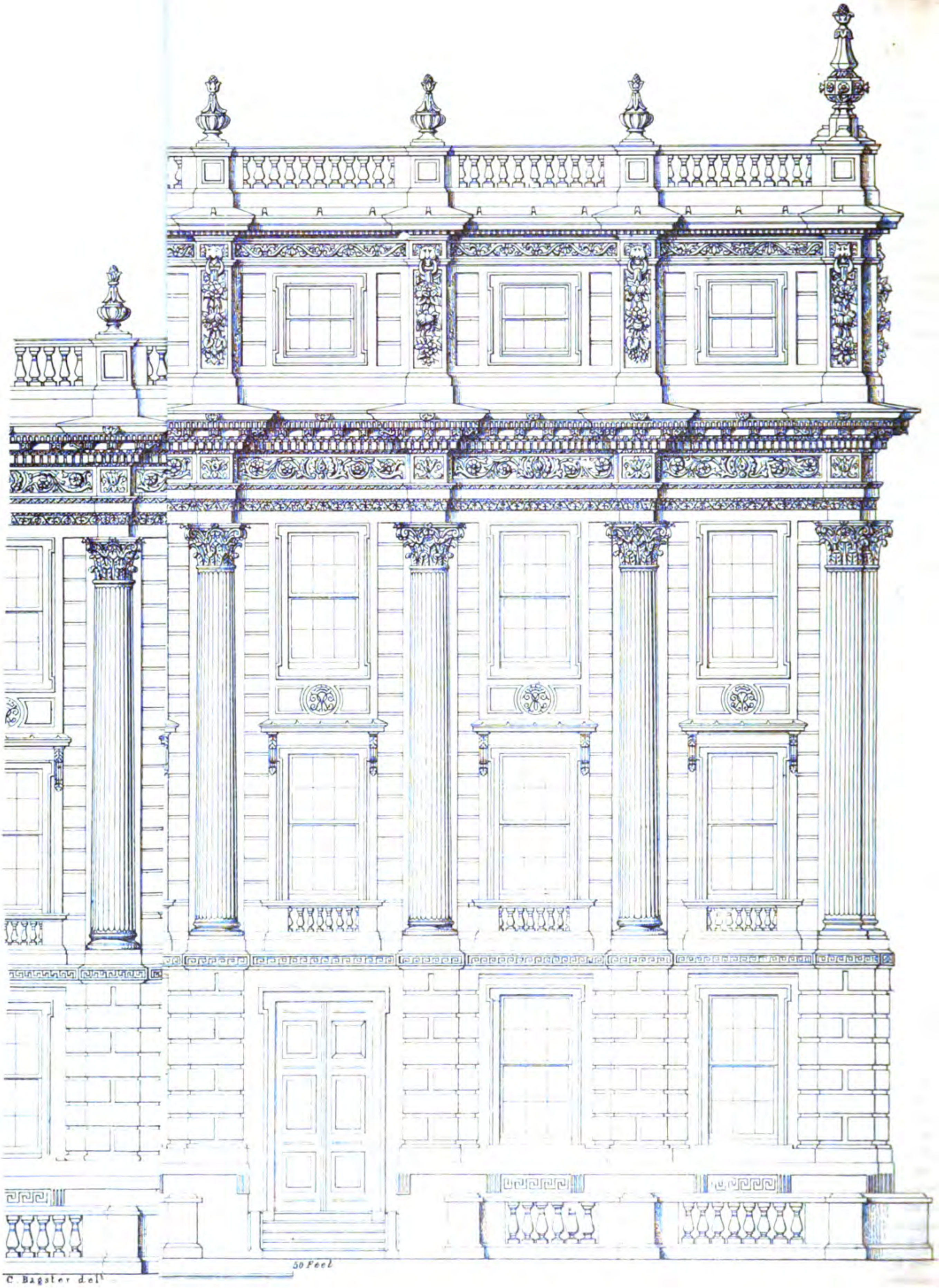
Augustus William Hillary, of No. 66, Cadogan-place, Chelsea, at present residing at No. 146, Avenue des Champs Elysees, in the city of Paris, esq., for "Improvements in the manufacture of gas."—July 23.

CORRESPONDENTS.

"A Working Mechanic."—The improvement of the hydraulic press is very ingenious, but the small end of the pump piston must work in the air: for if it work in a reservoir containing water, the water will be forced through the upper compartment into the main cylinder, and consequently the quantity of water pumped in at each stroke will equal the sum and not the difference of the volumes of the two parts of the plunge. If our correspondent will allow us to make the necessary alteration, the description shall appear next month. If we understand the action of the Archimedean air pump, the mouth of the spiral tube must alternately rise above and sink below the surface of the mercury. But as the exhaustion advances, the mercury would be elevated, till the mouth of the tube became wholly submerged.

From press of matter, the Reviews and several communications are unavoidably postponed.

ERRATUM.—Page 223, col. 2. The name of the architect of the New Post Office, at Hamburgh, misprinted "M. Charles Teusseuf," should be "M. Alexis de Chateauneuf," author of "Architectura Domestica," a work published in this country in 1839.



HALL.

HOME OFFICE, BOARD OF TRADE, &c., WHITEHALL.

(With an Engraving, Plate XIII.)

Twofold interest attaches to this subject because, as it exhibits a rifacciamento—a *re-dressing*, so to call it, of the former exterior, while the structure itself remains in other respects nearly as before, we have to consider not only the building as it now presents itself, but also what it has replaced. We have, besides, here a very remarkable case,—that of a building of quite recent date being subjected to complete alteration; while many others that might be materially improved by a much slighter degree of it—some of them even by a few corrections, remain in *statu quo* with all their blemishes: let us hope therefore that the example thus set will not be thrown away. Sir John Soane himself, we dare say, would not greatly have relished the idea of his "Board of Trade" coming to a *second edition* after his death; more especially as it was, with the exception of the "Bank," his principal and best work: but his design is now expunged, and what is more, after other things will have disappeared—as will shortly be the case—the front of his own house in Lincoln's Inn Fields will remain and be preserved intact to posterity as a monument of his taste. Hardly could Soane have conceived it to be at all possible that any thing which he had done should pass away, or else he would doubtless have ensured the perpetuity of his designs and ideas by means of the graver. It is true he did publish many of them in a folio volume, but they are so incorrect and exceedingly rude in execution, many of them of such paltrily diminutive size, and altogether so insufficient and unsatisfactory, as to be in some respects worse than nothing—more injurious to his reputation than the contrary. Were they to be judged of from that work alone, it must hereafter be thought that at the time of its production, both architectural drawing and engraving were at the lowest ebb in this country, since with all his wealth, and also his solicitude about his works, Soane could find no artists capable of doing them justice.—And here we may just remark *en passant* that engraving might almost as well be extinct among us, for any advantage that is now taken of it by English architects, wo hhave executed structures, that if adequately represented would obtain for them celebrity where their names are now not so much as heard of.

In the volume above alluded to, there is a plate containing several variations or different ideas of the design of the "Board of Trade," including the one adopted, but they are upon so preposterously small a scale (attached scale there is none)—the entire height, 54 feet, being only $\frac{9}{16}$ of an inch,—that they are mere diagrams, from which no more can be made out than the general composition, and the number of columns and windows. There would have been no harm in giving that plate, had there been also another showing the executed elevation at large, or rather only so much of it as could be shown on the largest scale the size of the plate would admit of; whereas now only the mere skeleton of, the elevation is there given, all its lineaments being suppressed. In the "Illustrations of the Public Buildings of London," again, it is shown very unsatisfatorily,—only a small outline *perspective* view; wherefore we purpose to record it faithfully next month in another engraving, in like manner and upon the same scale as the present one of Mr. Barry's new front to the Board of Trade.

Were there nothing else satisfactory, it would be so to know that the building will now forthwith be carried on northward as far as Dover-house, and the entire façade at length completed, as perhaps it would have been done before; had it not been for a most strange oversight in setting out the line of front, owing to which the North Pavilion could not have been erected without advancing considerably upon the pavement. Therefore if that really was an oversight on the part of Soane—and we can account for it no other way he has been punished for it, since the consequence of it may have decided for remodelling the façade in order to get rid of the advanced hexastyles at its extremities. Besides which, even had there been no obstacle to completing the building according to Soane's design, it would, when so extended to half as much again in length, have looked still lower than it did: whereas now there will be better proportion in the ensemble, and the entire façade will form a noble mass,—one that will show admirably well in itself, but which will perhaps overpower that little architectural gem Dover-house, and will certainly cause the Horse Guards (that is, its street front) and Admiralty to look more indignified than ever. In one respect, indeed, the contrast is an agreeable one, inasmuch as Mr. Barry's new piece of architecture shows, as compared with the two last-mentioned structures, the very great improvement that has taken place all at once in the quality of official and government buildings, which have hitherto been mostly made jobs of, and instead of conducing to the advance of taste, have in some instances been quite discreditable to the nation. The National Gallery stands a monument of the wretched system of doing things of the kind by halves: either a great deal too much was there attempted, or a great deal too little done; and should any thing more now ever be done to it, the expense will be very much greater than if it had been done properly at first, for there will be much to correct as well as to supply.

In the present instance every thing has been done most liberally: we have got, not as repeatedly before, what might have been good, or a good thing spoilt, but a really excellent one—a very superior example of its particular style, one that is thoroughly studied, and which therefore both deserves and cannot fail to become an instructive study and authority. While elaborately ornate it is marked by such refined taste, that rich as it is, it is the very reverse of tawdry. Numerous as the details are, there is not one that seems to have been neglected, or not to have been carefully considered by the architect. The whole and every part appears to have been done with relish —with true *gusto*,—without which, what is called art is only manufacture. If there be any thing which we could wish had been otherwise, it is, that the heads of the second floor windows had not been carried up quite so high, because they now break into the line of the lower edge of the capitals of the columns, which if not actually objectionable, is what is much better avoided; and no doubt Mr. Barry would have done so, had he not been over-ruled in that particular.

It is quite unnecessary for us to enter into a minute architectural description, because the engraved elevation, from Mr. Barry's own drawings, is upon such a scale that even the details are shown sufficiently distinctly,—an advantage that very far outweighs that of having the entire front represented in a plate of the same size. Had there been a marked central feature—one principal in the composition, the case might have been different; but as there is not, it being the extremities alone that are distinguished from the rest, and that only by the addition of an attic, both the composition itself is clearly enough made out, and the character of the whole intelligibly conveyed by as much of the elevation as is here represented,—which is rather less than half, there being thirteen windows on a floor, between the two end pavilions. To remove all doubt as to one point, that might otherwise be felt by those unacquainted with the building itself, we should observe that the middle compartment resembles the others, there being not even so much as an entrance there to mark it out at once to the eye as the centre. Perhaps a doorway there, of more ornate design than the others, either in addition to the four present ones, or as a substitute for the two in the middle division of the façade, might have been an improvement, but Mr. Barry was obliged to conform to the number and situation of the entrances determined by Soane's plan. There is also one peculiarity which has been forced upon him, in order to accomplish the raising of the columns to the level of the first floor; for they are placed upon projecting breaks or piers in the ground floor, that serve as pedestals to them; had not which been done, the thickness of the wall there must have been very greatly increased. While these breaks below produce a certain degree of variety and richness, they are in conformity with the treatment observed for the order itself, whose entablature is now made to break over the columns, and thereby, itself conforms to the treatment of the order, both the columns and their immediate portions of the entablature, being "*engaged*." Whether such effect has been an intentional or incidental result, this continuation of breaks upwards, throws a strong expression of verticality into the design, more especially at its extremities, where the vertical lines are prolonged by the attic pilasters, and their breaking cornices, and after being further carried on by the pedestals in the balustrading, terminate in the pyramidal vase-shaped acroteria.

The character of the rustication for the ground floor or basement of the order, has moreover been influenced and determined by the necessity for breaks in it, below the columns, it being thus reduced to nearly horizontal channels alone, with only a single vertical one in the alternate courses of each pier: what is here done however explains itself, and the effect is very different from that monotonous and *plank*-like appearance (without any indication of bond in masonry) which takes place when horizontal channels alone are continued uninterruptedly on the surface of a wall, without any jointing. In both the order itself and the attic, the rustication is treated with some degree of novelty, the channels not being continued quite up to the columns, but stopping against the edge of a narrow plain surface; whereby the rustics themselves are let into a sort of upright panel, not wider than half the diameter of the columns. And the panels thus formed, appear very much to assist the expression of verticality, which we have pointed out. We hardly need call attention to the development which Mr. Barry has given to his attic,—rendering it not a mere addition or excrescence to the order, but identifying it with the latter in point of luxuriant richness, and thereby rendering those portions of the design crowning ones in it,—parts which are to the general mass—what its capital is to a column, or its cornice to an entire order. The example of an attic, which he has here given us, is compared with the things of the kind we are accustomed to, what the *cornicione* in his Club-houses is to the meagre shelf-like cornices in that lean starvation style which so long prevailed in every style we affected. Barry will have given *embonpoint* to our architecture.

Leaving our readers to note for themselves minor specialities of design, which if their attention has been at all excited by what we have said, they will no doubt do, we will merely add that the north pavilion (the one shown in the engraving, and which is for the Home Office), together with the two adjoining compartments, has yet to be built, and will, we understand be commenced almost forthwith. When the entire front is completed, it will extend 296 feet, and be 56½ feet in its general height, and 67½ at its extremities.*

The structure is not only admirably finished up, but all of a piece throughout, every part that is at all visible, being strictly in accordance with what is completely seen. Thus the West side 'of the attic of the South or Downing-street pavilion, is finished-up like the others, although seen only partially above the adjoining buildings; for Barry does not countenance that miserable system of *pinafore* design, which leaves the end of a building—that is, as much of such end as really shows itself—whether intended to do so or not—quite bare and unfinished; as is the case with Inigo Jones' Banquetting House, just by, which as there is no probability of its unsightly ends being shut out from view by other buildings erected against them, ought to be completed externally. Unless that be now done, it will cut but a poor figure in comparison with Mr. Barry's new work on the opposite side of the street. The South-east view of the latter presents a striking contrast to the South-west view of the other, whose South end is a mere brick wall; whereas the South end or elevation of the Downing-street pavilion (the Council Office), is precisely similar to the East one (therefore to the one shown in our engraving), with the slight difference, that there are five windows to the ground floor, there being no entrance on that side.

If there be much to excite admiration in the building, there is also something to excite surprise, for surprising it is or would seem to be, that so superior a piece of architecture should have risen up almost all at once without any flourish at all of newspaper trumpetings, while the most vulgar nonsensical fuss is made about the most trumpery buildings imaginable, merely because somebody or other who is a somebody, performs the farcical ceremony of "laying the first stone," as it is called, to the great edification of all the nobodies who *assist* on the important occasion.

Fig. 1.—Plan of First Floor, Windows and Columns.

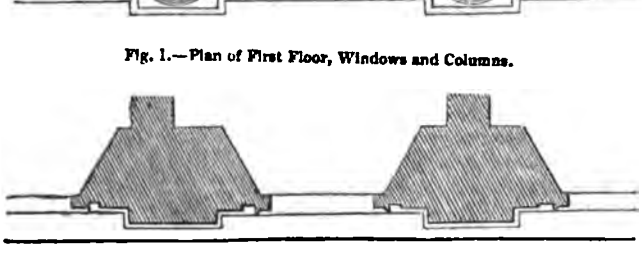


Fig. 2.—Plan of Ground Floor Windows and Balustrade.

* Height from pavement to bases of columns	19 ft.	0 in.
Height of columns	25	6
" entablature	7	6
" balustrade	4	6
" attic	11	0
Entire height..	67	6

CANDIDUS'S NOTE-BOOK. FASCICULUS LXX.

"I must have liberty
Withal, as large a charter as the winds,
To blow on whom I please."

I. As Wightwick vows to go, D.V., to Naples and eat macaroni there, it is to be hoped that he will not forget to bring back with him some pen-and-ink sketchings—and if he like, some pencil sketches, too, of the recent architecture of that city. There is sufficient *pabulum* of that kind for his pen,—the church, for, instance, by that un*Naglerized* nobody, Bianchi. And let him portray that and whatever other buildings he speaks of, *architecturally*, so that we may be able to make out a tolerably distinct image of it, not a mere formless, shapeless Ossianic spectre. Let him take a lesson from the novelists:—they after all are the people for exact and conscientious description; they are content with nothing less than that of giving us a complete inventory of a heroine's "*personals*," noting every item separately,—though with all their exactitude they never inform us of her exact weight—the weight of a mortal "sylph." As to Vesuvius, we can very well dispense with any remarks on that *from* Wightwick; so let him eschew speaking of its crater—that *bore* of tremendous calibre,—or we shall wish that he had fairly jumped into it, and like Empedocles, distinguished by extinguishing himself within it.

II. It is curious that we should be indebted to a Cookery book for a detailed plan of the kitchen offices in the Reform Club-house. M. Soyer has supplied a leaf that was very much wanted in architectural lore, for those who have published plans of town mansions, have never revealed t us the complex *arcana* of their below-ground territories, but have literally passed over them, as matters altogether beneath them,—*low*, vulgar, and *infra dig*. Yet the arrangement of the numerous separate rooms requisite for an extensive domestic establishment, within the basement of a town residence, calls for the exertion of more than ordinary ingenuity and contrivance. A collection of a dozen basement plans, minutely detailed and explained, would form a series of valuable and useful lessons. There then, is an idea at once for a publication of entirely new character. So let some one now take it up. But no,—nothing will take or go down with the profession or the public, that does not address itself to and flatter the present church-mania, and the passion for studying Roman Catholic "*rubbish*." What with churches, church furniture, and church upholstery, on the one hand, and with railways on the other, the demand for architectural publications of any other kind, seems to have ceased. Archæology is all very well in its place, as the *handmaid* to architecture, but it has of late given itself such airs, and domineered at such rate, that it is time for it to be taken down a peg, and not be suffered to keep poking all sorts of paltry old trumpery in our faces, and insist upon our admiring hatched-faced saints, and angels with dislocated limbs.—Let us escape to the kitchen.

III. Talking of escaping to the kitchen, reminds me that the kitchen itself has completely escaped the attention of that great architectural encyclopædist, Gwilt. Even so; his fat Falstaff tome contains nothing whatever on the subject of kitchens and their accessories, and the multifarious apparatus belonging to them; an omission the more remarkable considering how much stuff—stuffing I mean—he has crammed into his book, that one would never think of looking for in it. He has indeed given the word "kitchen," a place in his Glossary,—and very properly, it being so strictly technical a term, as to render explanation of its meaning, indispensable,—indispensable at least for the information of those over-and-above genteel young ladies in middling life who are presumed never to have entered a kitchen, or to know what sort of operations are carried on in one. It is only thus that the insertion of such a word can be accounted for, while so many strictly architectural terms which are not to be found in general dictionaries, or even in encyclopædias, are omitted. Nor are omissions of the last-mentioned kind the most remarkable of all in Gwilt's book, because he has chosen to omit Rickman's well known work in the list which he gives of publications on Gothic architecture. I say "chosen" to omit, because it is not for a moment to be supposed that he was ignorant of the existence of a work which besides being exceedingly useful as a synopsis or catalogue of English structures in that style, is continually referred to as an authority. There are besides what look very much like instances of *intentional* forgetfulness, in regard to other publications, which though not mentioned by him were as well or better entitled to such *distinction* as very many of those which obtained it. That on Barry's Travellers' Club-house, is of sufficient merit if only on account of the examples of Italian detail given in the plates, to have been worthy of a place in the list of works on Italian architecture; and its non-insertion is all the more remarkable because Gwilt himself points out for particular admiration, and as example in which "the principles of that style are so admirably developed," the façade of the Palazzo Pandolfini, to which the Clubhouse above-mentioned bears a more than casual general resemblance. Possibly, however, Mr. Gwilt never saw or heard of the book; and if so, he will thank me for pointing out both that and Rickman's, that he may insert them accordingly in the next edition of his valuable Encyclopædia.—Apropos to Rickman,—the German *Nailer* (Nagler) has not nailed him in his Lexicon, though he has nailed up there an immense number of obscure or else quite forgotten names—some of them the smallest of the small-fry artists. Well then, all the more industry and greater research does it show to go and pry about with a farthing candle, and peep into all the crevices and crannies of tenebrous obscurity, and turn out the poor little things that lay there ensconced.

IV. The "Times" has been very pleasant à la Punch, on that *Nash*ional calamity, Buckingham Palace, which it is now discovered is hardly habitable, neither Nash nor George IV. having any idea that royal nurseries could ever be wanted within its walls, and not nurseries alone, but apartments for a whole colony of tutors and preceptors. As to a mere nursery—that is already provided, there being nothing more required than to make use of the "Garden Pavilion" for such purpose, for which indeed it appears to have been actually intended, it being so very pretty, all covered over with "nice darling little pictures"—exactly what a royal baby-house should be, with a kitchen and other "conveniences" attached to it,—a proof that it was built not only for show, but for service. The idea of so making use of it, was perhaps abandoned, because it was found not sufficiently large for the purpose; yet surely it is just as easy, and would be as CHEAP to build additional rooms out behind it, as to enlarge the palace itself. If Mr. Blore will take this hint—and he ought to jump at it—it will spare him a great deal of pathos, and perhaps no less perplexity also, since perplexed he, no doubt, will be to patch up decently the Park front of the Palace, on which side it is proposed to add another range of buildings, filling up the space between the wings, and enclosing the open court in front. In doing merely that, there will be no particular difficulty; but unless the wings themselves—the ends of them at least are to come down, and to be taken into the new East front, either what comes between them must be accommodated to them—made of a piece with them, in which case the architecture will be just as mesquin as at present, or the whole will be more or less a piece of patch work. It will be necessary also no doubt to advance the new building before the present line of front, and continue the wings also for the same distance, because unless that be done, what will then be an inner court will be smaller than the present open one; besides which the side elevations of the wings towards the court must either be altered accordingly, or their regularity would be destroyed;—as may be seen by one of the plates of plans and elevations of the Palace in the improved edition of the "Public Buildings of London,"—which, if never looked at before, are likely to be so now, out of curiosity, and in order to judge what contrivance can do for improving the building.

V. Whether Blore be a great master as to contrivance, I know not, but it may be questioned if he be exactly the right *B* for the occasion, or likely to improve the architectural quality of the Palace. What I have seen of his, is marked by littleness and feebleness of manner; and though he has had some favourable opportunities—Lambeth Palace for instance, he has done nothing at all of a superior kind, nor is any work of his ever quoted as manifesting more than ordinary talent. In one respect he is a copyist of Sir Robert Smirke, for like him he has a horror of exhibiting at the Royal Academy, and exposing any of his designs to the profane gaze of the multitude. Pity that such architects can not keep their buildings as well as their drawings secluded from public view.

VI. There is one notable inconsistency in what is rumoured relative to the alteration of the Palace:—the works, it seems, are to be carried on with all possible dispatch when once commenced—the necessity for which is sufficiently apparent, and yet only £30,000 per annum is to be voted for the purpose, although £150,000 is the estimated expense—at present, and if there has been any miscalculation at all in the matter, it is easy enough to guess on which side the mistake will be found to lie. But I forget,—the Pavilion at Brighton is to be sold towards paying expense—of taking it down, perhaps, unless some railway millionaire should happen to take a fancy to it, and offer to give a good round sum for it,—about a tenth of what it has cost first and last. Yet that would be horrible!—only think of some mushroom man of money installing himself in the pet *place* of George the Fourth. Poor George! poor Nash! poor Soane! methinks I hear the ghosts of all the three abusing "Posterity" for its villainous taste, and for committing such deadly havoc with their works. Carlton House gone, George III's Gothic Palace at Kew gone, the Pavilion going; Soane's "Board of Trade" so metamorphosed that it does not know itself, the Scala Regia going, "my Law Courts," too, going—about to be knocked down, though not by George Robins' hammer, and now Buckingham Palace to be improved!—improved indeed! as if what the newspapers, at the time of its being built, and John Britton also spoke of as an august metropolitan palace becoming the dignity of a British sovereign, could possibly admit of improvement. Oh dear!—but it is all owing to the March of Intellect.

VII. One comfort is that it will now be more work for the "Silver Trowel," as no doubt the first stone of the new front of the Palace will be laid with all due pomp and ceremony, if only for the benefit of the newspapers, which invariably take prodigious interest in such operations. Prince Albert must by this time be quite a proficient in the art of handling the trowel, if in no other; but his Royal Highness seems more ready to lend a hand that way, than at all to care what the buildings themselves will turn out. There is a little pigmy—I might almost say piggish or priggish—thing growing up in Oxford-street, the first stone of which was laid by the Prince on the 16th of last June—happy and memorable day!—but all the other stones after that first one have changed into bricks, which are to be compoed over; and whatever it may turn out in other respects, the front will be a most minikin affair. Moses—Minories Moses, I mean—will turn up his nose at it, as a thing that he could easily stow away in his own shop. Of course the Prince did not see the design, or he would have employed the trowel differently from what he did, by plunging that instrument into it. Hard work that some first-stone-laying, considering the precious balaam that must be listened to on such occasions. However the Prince is relieved from the drudgery of *Cabinet*-making.

ARCHITECTURAL RECOLLECTIONS OF ITALY.

By Frederick Lush.

(*Continued from page 231.*)

"Architecture (where it was not a mechanical art dependent on mere convenience, and upon the rule and plummet) was an emanation of the arts of design, and consequently, in everything that regarded its more liberal concerns, its beautiful and majestical effects, as a whole and parts, it was the pure offspring of drawing or modelling, and absolutely and solely depended on the composition of forms, and the compositions of chiar'oscuro and relievo which those forms produced."—Barry's "Lectures on Painting."

The most important constituents of beauty and grandeur in architecture are mentioned in the above quotation. They can only manifest themselves in art in proportion as that mind is imbued and acquainted with the principles of beauty which we find are requisite for the painter, and by which alone the architect is distinguished as an artist who thinks and feels, from the mere mechanic who measures and builds. How necessary then it is to possess these principles will be very apparent. Architecture, as a fine art, must be judged of by its agreeable effects and expressions—a cultivated eye or mind being the arbiters in these results. But the architect must need have a strong perception of several painter-like qualities—of the composition of beautiful forms, chiar'oscuro, and relievo—before he can give that expressive character to his works which fills and elevates the mind, in the same manner as poetry and painting. To accomplish this end is the chief glory and ambition of the architect. But to what motives and to what ignorance are such noble ends too often sacrificed?

This art being in its nature so *utilitarian*, necessarily demands an acquaintance with those general principles of art which, combined with its *utility* and *fitness*, may afterwards invest it with that poetic character which all works must have whose ultimate and grand object is to affect the imagination. The Italians, at the revival of art, who applied the principles of painting, i. e., drawing, harmony of light and shade, &c., to architecture, eminently succeeded in this particular; but their works, and the effects they produce, could never have been created but by this combination. Were proofs wanting, look at Michael Angelo—perhaps the grandest painter, one of the greatest architects; look at St. Peter's and his other works. Then Raffaele, greatest in expression and beauty as a painter, is he not elegant and beautiful in his architecture? Villa Madama and other buildings may occur to the reader as illustrations of this truth. Again, what is more elegant, simple, and lovely, than the Campanile of the Duomo, at Florence? And was this not the work of a painter, and when painting was in its early days of purity? Yes; Giotto was great both as a painter and an architect. And why are the works of such masters never forgotten when once seen; that even in presence of them they seem as if they had been called up by enchantment; and that at an after period they so frequently come before the imagination like dreams? Why, but because of their extraordinary and powerful *effect*; because of that beauty and grandeur in composition, which give life and intelligence and poety to building. They well knew that architecture required to be distinguished by such forms, such magical effects, such prominent bulks in the grand mass, as would produce this, and with it a most lasting impression. Where such thought and mind is evidenced in the works of the Italians, there is ample atonement for their defects, which are numerous; just as in the earlier paintings fine feeling and expression, make us forgive every anachronism and absurdity.

The noble group of buildings in that solemn square at Pisa, the cathedral, baptistery and campanile (whose beauties we owe more to painters and sculptors, than architects,) whether each is viewed as a whole or in detail, are further instances of the incalculable benefit architecture derives from a thorough understanding and practice of the union of the principles of the sister arts. Very many other names might be brought forward and examples mentioned to show that these men, when they took upon themselves to build and adorn, possessed a painter's perception of beauty. Each brought to the task and ennobled his design by applying the principles of painting and grounding it not so much on antiquated rules and precedents, as on the eternal laws of taste, harmony, and proportion existing in the mind; who, from the enlarged and comprehensive view he had of art, knew more than the subject demanded when he commenced the work; felt the nature of the idea his building was made for; saw his work was made for the place, and took care the place was adapted to his work.

Now, the neglect of these principles of painting among English architects is, with some few exceptions, the main cause, we think, of bad architecture, want of originality, &c., and one reason why we observe the art so often degenerates into a mechanical trade. We seldom see originality,—and where it does occur, there is little taste; and beauty is another word for the evidence of the existence of pictorial faculties, and indicates or reflects a mind that is conversant with the beautiful forms in nature.

Those principles (referred to by Barry) of uniformity and variety which must be pursued in the arrangement and construction of all forms which enter into the composition of buildings—are executed with the greatest success by him who is most capable of conceiving and delineating fine forms—and this power of drawing is very much neglected by the English student.

I of course allude to the study of the human figure, for all drawing implies a knowledge of that, and deserves first consideration, as it is this alone which is the best means, in the first, as well as in the last step of the art, for cultivating the eye and filling the mind with ideas of beautiful form, which facilitate and ennoble design, composition, and all the effects of chiar' oscuro resulting from them.

The prevailing practice is to begin with architectural inanimate lines, and copy ancient examples, before any part of the human body or even ornament is attempted to be drawn: the one has a vicious tendency—cramping both the hand and intellect; and the neglect and ignorance of the latter makes the power of adding the beauties of ornament, the foliated capitals, the enriched friezes, &c., at first an unconquerable and disgusting difficulty to the tyro.

Without a knowledge of the principles of design, we cannot give that contrast, elegance of line, and variety of form which, bearing in mind the purpose of the building, add to its beauty. A knowledge of chiar' oscuro will enable the architect to combine the various parts of his work with such general effects that, while every part may be beautiful in itself, such beauty will be but a part to increase the ensemble of the whole building. "It is he alone," as Barry says, "who, from the sure and expansive principles of composition and chiar' oscuro, can pursue beauty and sublimity in a thousand different ways; whilst, without these essential requisites of design, men are but mere builders, and must unavoidably copy or plunder from the works of those who are gone before them; and in either case, the absurdities that may result from the difference of climate, local situation, and from ill-according particulars, however beautiful in their own original proper arrangement, are too obvious to be mentioned."

But a knowledge of chiar' oscuro will prompt him to dare to give relief and power to his work as he can combine light with shadow, and play with relief till his idea of effect is fully carried out. In our old Gothic cathedrals, what richness and variety—what effect! how powerful they look, and eloquent and grand they are! In the numerous churches that have been erected in imitation of them, we see, with only a few exceptions, in their effects, the deficiency of architectural spirit and talent in their authors. In general what sameness—how barren and unmeaning they seem! as if they had tottered out of their places—and could not stand there long. So far short do they come of those glorious models of the 13th century—such meanness is there instead of profusion—such saving instead of cost—such reduced proportions and littleness of manner—that although the Gothic may be more appropriate to our Christian churches than the Classic Roman, there is far more beauty and skill observable in the spires of Sir Christopher Wren, than in those of the modern Gothic builders. The skill displayed in the construction of the spires of Wren, and the ingenuity with which he applied the ancient orders to the modern Campaniles, for which he had no authority, deserve our admiration. They exhibit, too,—many in an eminent degree—the principles advocated in this paper. We observe such simplicity, yet such variety—such a fine relief and "making out" of the parts, and to an extent which in vain we look for in the flat modern Gothic towers, &c.

It is a knowledge of these principles—valuable in their application to every branch of art, but more especially to architecture—that is the source and inspirer of originality. Hence the old Italians, though little professing architecture, possessed qualifications which raised and ennobled it; their inventions are steeped in beauty, for they were drawn from the infallible principles which guided their practice. And the opinions upon architecture as a fine art are always to be accepted and preferred before the judgment of architects, why then separate from their profession a knowledge of painting.

STAINED GLASS WINDOWS.

St. James's Church, by Mr. Wailes.—Woolwich Church, by Mr. Headley; from a Cartoon, by Mr. Corbould.

The two new windows lately completed, in the opposing styles—modern and ancient—which now engross so much attention, afford a good opportunity for instituting a contrast between them. The ancient window, or rather, series of windows, at St. James's Church, Piccadilly, consists of an upper and lower range of compartments, separated by a deep entablature. In each range are three lights, divided by columns: the painted glass with which each light is filled exhibits a scriptural subject contained in a panelled centre or medallion, which is surrounded by a wide border of mosaic work, with an additional circular mosaic ornament introduced in the lower part of the upper centre compartment. The drawing, though superior to that of many of Mr. Wailes's former productions, is very inartistic,—the arms and legs appear to have been stuck on, as though the painter had copied some Dutch doll, made to scale, and wrapt round with cloth of various hues, for a model. The flesh tints and other colouring must have been done from some of those Italian glass paintings frequently seen decorating (!) many of our agricultural labourer's cottages—they exhibit about the same taste. The Mosaic work has little pretension to consistent design; it is distinguished by all the beautiful "regular irregularity" of the kaleidescope, and could not, we should have thought, by any chance have been executed in any other way,—the colours are so varied and the pattern so heterogeneous.

As we happen to be a little in the secret, we may perhaps be excused in explaining how this competition was managed. We believe it to have been all fair and above board at first, and that many of the committee did, after looking many times over the several designs, choose one, extolled it, and were delighted with its originality, grandeur of conception, and extraordinary talent. It was but a sketch—but we all know what the sketch of a good artist is,—and they determined to make it their own. It appears, however, that after the committee had come to this resolution, they were informed by the Bishop that he liked not this modern style of glass painting—that it must be ancient "for his money;" mosaic work, with figures and all that sort of thing; which he thought the best adapted to this window;—and then, by some extraordinary argument, dictation, or power of patronage, did he win over this said committee to his views, and the result now appears to stain, not the window only, but the character of England, as a nation of taste.

The sketch first chosen we have seen, and pronounce it to be, in our humble judgment, one of the best conceived designs we ever beheld, either from ancient or modern painter. The lower part was the removal of Our Saviour from the Cross, and a cross on each side for the thieves. The principal cross and figures would have occupied the centre compartment, and one of the other crosses, with the thieves and subordinate figures, the sides;—but although thus separated, the subject was so well managed and balanced, as to appear one picture. The whole was treated as a night scene, and lighted up with burning fuel in vessels with long handles, held by attendants; giving a sombre and grand effect to the solemnity of the scene. The upper windows would have contained the "Wise Men's Offering," consisting of splendid figures of all nations, attending on camels with canopied seats, and other display of Oriental magnificence, seldom before embodied in one picture. These would also have occupied the three upper compartments, as one picture. Thus would have been exhibited the Birth and Death of Our Saviour, treated in a bold and original manner, and, from the well-known talent of the artists, could have been executed in a way that would have revived the art of glass painting, and have been a proof that there are *now* those who can produce better things than ever ancients did, and redeem the art from its present degraded state. This sketch was by Mr. Corbould, and was to have been painted on glass by Mr. Hoadley, from Mr. Corbould's cartoon, who would otherwise have assisted in the progress of the work.

The St. James's window has been in contemplation so long back as thirty years, when Mr. Backler was actually commissioned to make a design from the Transfiguration by Raffaele, and was engaged to execute the work, but by some unforeseen circumstances has been unfortunately delayed to this day to give place to another, who declared himself incompetent to paint the window in the style required, but was nevertheless chosen for that purpose!

We do not so much complain of Mr. Wailes,—he would have been to be pitied, had he not pocketed the good round sum of 1,000*l*, for his labours, which may, in some measure, cover any little annoyance he may receive from the indignation of the public; but we do blame the committee, without the least reserve, for allowing themselves to be seduced from the right path and dictated to in a matter of such importance; for it is not the St. James's window alone that may be subject to this degradation,—but the tendency to imitation is so strong in this country, that many other parishes will follow this vile example, for although many excellent examples of painted glass have been done of late years in distant parts of the country, yet this abominable trash, called Mosaic work, is still patronised and selected by a committee who, of all others, from its position in society, should have known better.

The pleasing effect of old stained glass, we well know, is not always caused by good drawing; on the contrary, it is produced by harmony of colours and a mellowness obtained by time. This gives that richness and beauty so much extolled in ancient windows; but it is no argument that bad drawing should be used; as it stands to common sense, that were the subjects better treated, the beautiful effect would have been greatly enhanced and the educated eye would not have been subject to the disgust now experienced on viewing the caricatures so often seen on old glass. Let any one attempt to decipher the subjects of many ancient windows, and he will find it as great a difficulty as transposing an Egyptian hieroglyphic.*

The Woolwich window, painted by Hoadley, is in the pictorial style, from a cartoon by Corbould. By a singular coincidence, these are the same artists who were to have executed the St. James's window, if the committee had not been deterred from their good judgment by the ecclesiastical dignitary. This window is 14 feet high and 6 feet wide, circular headed, and contains but a single figure—that of Christ bearing the cross, with a wide border and pedestal beneath, the latter having been judiciously designed to shorten the window and give the picture a better proportion; upon this the emblems of the palm branches are introduced with the touching motto—"CHRIST bearing His cross went forth." The figure is colossal, being at a great height and generally viewed from a distance; the features of the face depict sorrow and suffering, and the hands and arms are well executed and doing duty—not mere puppets to the figure, as at St. James's; the drapery is broad, and allows of a depth and mass of colour which give dignity to the picture, exhibiting those splendid ruby and purple tints said, by the ignorant, to be lost; the border judiciously introduces the passion flower, well executed and entwined in scroll work.

There is a grave solemnity about this single figure that strikes the beholder with religious reverence, at the same time there is a pleasing harmony in the colouring and design of the rich border, which relieves the principal composition. It is a contrast—and a bold one too—to that style we have just denounced in the St. James's window, and so much admired by ecclesiastic patrons of the art. We would seriously advise these gentlemen to look "upon this picture and on this," and try for once to clear their vision, so as to distinguish gold from tinsel, art from kaleidescope, talent from mechanism, and then decide whether 'twere better to remain in ignorance or to recant those bigotted notions they have heretofore so strongly held, and, although at the eleventh hour, to assist this degraded art, and make it one worthy of an intelligent nation.

* At the time of the Revolution, many of the painted windows in our cathedrals were taken down and packed away in hiding places, to be secured from the violence of the Puritans. When the glass was subsequently replaced in the windows, the work was frequently confided to those who were imperfectly acquainted with the original design, and therefore unable to reproduce it accurately.

ARCHITECTURAL IMITATIONS.

—— *esse quam videri malebat.*

In the introductory note to the present volume it was stated that our architectural criticisms would be based on the doctrine of faithfulness in architecture; and accordingly in the paper immediately following, the practise of using imitative materials in building was discussed and condemned. It was hoped that this and similar papers, if they failed of producing absolute conviction, would at least preclude the chance of our views on the subject being misapprehended. It appears, however, from some observations in our last number, that this hope was ill-founded, for we are by a side-wind accused of uttering sentiments which, if legitimately carried out, would lead to a condemnation of the use of gilding in architecture.

Gilding, as ordinarily employed, is not a deception. No one who looks at the gilded boss of the vaulting of a church-roof is deluded for an instant into the idea that what he sees is solid gold. Not only is he not deceived, but there is no attempt made to deceive him; for the position of the boss among other stones sculptured in a similar manner, and many of them painted of different hues, plainly shows that the gilding is nothing more than a means of giving to the stone a beautiful colour. When however gilding is used to make the substance beneath it seem to be solid gold, it becomes at once a paltry contemptible deception. The flashy gentleman (or gent) who wears gilded rings will generally prove, like his jewellery, a counterfeit: not in outward appearance only, but in education, feeling and language also, he will be found to be a gentleman in semblance alone.

What matter, it is asked, though the beauty which invests works of art be only skin-deep? If it be *no* matter *at all*, why then should stone and marble and costly woods be *in any case* preferred to less expensive materials? If the deception can be practised to perfection, why should we have the least preference for the reality? But as a matter of fact we *have* that preference —there is not an architect in England who would not always, if he could afford it, use real stone rather than the most perfect counterfeit. The existence of this feeling proves that the mere excellence of the counterfeit does not remove *all* objection to it—that the imperfect nature of the deception is not the *only* argument against its employment.

Let us suppose it to be discovered hereafter that the noble piers of the nave of Canterbury Cathedral are not Portland stone but Portland cement, and that the shafts of the Norman choir are not Petworth marble but stucco overlaid with black varnish, and that the beautiful foliated ornaments of the crockets, pinnacle-work, &c. were not sculptured by the hands of skilful artists, but were run in moulds by common workmen—would our admiration of the building be increased or diminished? Why should it be diminished? The imitation was perfect; we have supposed it to remain for centuries without being discovered, and though the beauty be only skin-deep there was no outward signs to reveal that circumstance.

Or to take a commoner illustration—the descriptions of public entertainments usually enlarge on the magnificence of the display of gold and silver plate, and the splendour of the jewellery work by the guests. Would the description be more or less glowing if it were found that what seemed gold or silver was merely electro-plated, and that the diamonds were only paste? Why should people care to have the Hall-mark on their dinner-service? Britannia metal is exactly the same colour as silver.

But we are told that it is no argument against deceptions, that they are "apt to be paltry." This may be disputed—for if all the paltry imitations were got rid of there would be scarcely any left to dispute about. And is it not obvious moreover that those who practise paltry imitations will shield themselves under the sanction of those who defend more costly deceptions? So that in fact these defenders are in fact fairly chargeable with providing excuses for the most miserable expedients of sham showy architecture.

Let us consider for a moment what are the imitations most generally practised. By far the most common of them is the expedient of smearing over the honest bricks actually employed in the construction of a house with a coating of plaster, on which vertical and horizontal lines are drawn with the point of the trowel. It may be fairly assumed that at least half of the newer houses in London are ornamented in this way. Occasionally the lines, especially inside churches, are drawn in black lead! What miserable expedients are these? Can any one for a moment be induced to suppose that a few thin black lines represent the joints of real masonry? They show all the intention of deceiving, but are too clumsy to effect the deception. Another favourite expedient is to paint the stucco of a uniform colour, and then *spatter* it over with spots of dark paint, by means of which it is supposed to assume the appearance of granite.

It may be assumed that no one sincerely desirous of maintaining the dignity of architecture as a noble art will defend these wretched juggles. But the condemnation rests not merely on their unsuccessfulness, for then a thief by parity of reasoning ought not to be punished unless taken in the fact The true ground of condemnation of all architectural deceptions, whether successful or unsuccessful is that they "partake more of mere manipulation than of art." They tend to substitute the workman for the artist, the builder for the architect. Unless, as has been well observed by the *Builder*, the *skilful* hand be apparent, the result is disappointment rather than delight. It is to this consideration we must refer for the cause of the failure of all the save-trouble expedients which have so long exercised their pernicious and debasing influence upon architecture and the other fine arts.

But there are many other arguments against that class of save-trouble expedients which we are more particularly considering. Imitative ornaments are necessarily inconstructive. A pillar or pilaster of stucco *must* be stuck on for show—the material has not sufficient cohesion to be useful in resisting either vertical or lateral pressures. Again, there is a practical tendency to evil in the system of imitative decoration, which if it be not an actual part of it, results certainly form it—namely, the introduction of redundant and inappropriate ornaments. The facility of being showy is certain to be abused: the temptation is too strong to be resisted by those who make the common mistake of confounding architectural beauty and elaborate enrichment. Accordingly we find plaster-architects bedizening their work with a crowd of ornaments as ridiculous for their number as their inapplicability. A building with showy bits of plaster thus stuck over it reminds one involuntarily of a village landlady tricked out in her myriad of Sunday ribbons.

They who defend deceptions in building should remember that for the sake of consistency they should be prepared to vindicate *all* such deceptions if well executed. If an architect wish to introduce more windows into an external elevation than is convenient for the internal arrangement of the building, why may he not *paint* resemblances of those windows on the external walls? The deception might be managed so well that it would scarcely ever be found out. The ornament would be only skin-deep to be sure; but what of that? Why should not the great doors of a cathedral be of deal grained and varnished to look like oak. Why should not the timbers of the roof of Westminster Hall be painted so as to appear elaborately carved? or why should not the parapet of the external roof be painted to look as if panelled or perforated? The triglyphs of a Doric order might be *drawn* in their proper places instead of being sculptured there, and the more inaccessible columns might have the flutings painted upon them. This seems the legitimate development of the the theory of architectural deceptions.

It is gratifying to those who are anxious for the advancement of architecture to find that the importance of faithfulness in architecture is being every day more distinctly recognized. The rapid growth of this doctrine even the last year or two is a most favourable indication that art is not to remain for ever in its present degraded condition. Every periodical which treats on subjects of art new recognizes this principle of criticism, and contains correspondence which proves that the detestation of plaster Gothic and plaster Grecian is becoming pretty generally diffused. Of course those who have long practised or defended these kinds of architecture are very angry at having their favourite tenets cut up by the roots: but they will generally acquiesce when they find the tide of opinion too strong for them and silently adopt the principles which they find it in vain to oppose. Those few who have too little wisdom or too much obstinacy to yield to the dictates of improved public taste will be left behind to enjoy their own opinions in undisturbed solitude.

NEW METROPOLITAN CHURCHES.

All Saints, St. John's Wood.—The new church which has been recently erected in the Finchley Road, St. John's Wood, from the designs of Mr. T. Little, is, as regards the exterior architecture a great improvement upon the churches built in and about London ten years ago. The general character of Mr. Little's design is an unpretending simplicity, which if it do give opportunity for the display of much original genius, at least precludes the occurrence of gross defects.

The plan of the church is nearly a parallelogram—a nave and two aisles, with lean-to roofs, a tower at the north west angle, and at the east end a prolongation of the nave which, though too shallow to be called a chancel, serves the purpose of a sacrarium. The style is Perpendicular. The following are the principal dimensions.

Extreme length	96 feet.
Width of nave	30 „
Ditto including aisles . . .	61 „
Depth of sacrarium	20 „
Rise of nave-roof	19 „
Height of apex of ditto from the ground .	55 „
Height of nave-arches	28 „
Span of ditto	20 „

The tower is designed to consist of three stories surmounted by a spire, but at present the first story only is finished. In the west gable is a four-light window, beneath which is a small door (with very poor mouldings) for the use of the soldiers of the neighbouring barracks. The north and south windows are the least praisworthy features of the external architecture. The window at the east end is of five lights divided by a transom.

One of the principal reasons of the satisfactory appearance of the church is the judicious manner in which the architect has used his building materials,—Kentish rag with Bath stone dressings. The ragstone instead of being squared and laid in regular courses (a most expensive and ineffective method) is built in what is technically termed "Random-coursed work." It is a matter of great regret that in many modern churches the ragstones are hewn and laid with the same precision as softer kinds of stone, and that the joints of mortar are moulded so as to give the appearance of projected fillets, in which, as has been observed, the individual stones appear set as in frames. This method is very faulty; it arises from the almost universal ambition of modern architects to make their materials look better than they really are, instead of applying them honestly to the purposes for which they are naturally adapted. The very fact that this coursed ragstone masonry presents the appearance of rustic work is quite sufficient condemnation of it. The practice not only adds to the expense on account of the hardness of the material, but detracts greatly from effect of the masonry. Our old country churches are proofs not only of the beauty of the irregular ragstone masonry, but also of its durability: for a familiar example near London, we may refer to the tower of Lambeth church. Alas, when will modern architects build with the boldness and picturesque simplicity exhibited in that structure?

The interior of the new church, at St. John's Wood is by no means so praiseworthy as the exterior. The internal architecture is in fact as bad as it well could be. The span of the nave arches and the width of the nave are disproportionately great. The north and south windows are treated as mere holes cut in the walls, without any dressings or mouldings to connect them decoratively with the rest of the building. The difference between the forms of the inner vault of the windows and the exterior window opening, which in ancient Perpendicular architecture is a principal source of beauty, is here entirely disregarded. The piers and windows are intersected by galleries supported on paltry cast iron columns. The mouldings throughout are very poor and shallow.

The walls are coated with some kind of plaster on which are drawn black lines to mimic the courses of real masonry: over the heads of the windows and doors these lines converge and suggest imaginary arch-voussoirs. Can any artifice more paltry and palpable be imagined? Were it not so common it would be absolutely laughable. The trick is as shallow and obvious as that of the ostrich which is said to hide its head to escape pursuit. Even if we allowed (which we do not) that deceptions and imitations were at all permissible in building sacred edifices, surely they should be better managed than this is. It is merely a child's make-belief—no one can be deluded for a moment into the idea that a few indentations and black streaks are are the joints of real masonry. The artifice should be reserved exclusively for gin-palaces and the lath and plaster edifices dignified by the appellation of *suburban villas*.

The church is filled with low ugly pews of deal stained and varnished: this staining is another ridiculous deception, an abortive attempt to make deal look like a better kind of wood; whereas in fact it looks much worse than in its natural state, for the varnish renders the coarse grain and misshapen knots of the wood offensively and unnecessarily conspicuous. In village churches where the deal boards are either painted of some uniform colour not imitative of a costlier material, or left in their natural state, the lines of this unornamental wood are little seen, and consequently the appearance is comparatively unobjectionable. But to make an ostentatious display of the "figure" of a wood which has no beauty to recommend it is a piece of vulgar pretence, which we always rejoice to see proved, as in the present instance, a complete failure.

There is a large family pew for the minister screened off from the rest of the church by a curtain; the privileged inhabitants of this pew are therefore enabled to offer up their praises and petitions unseen by their fellow sinners assembled and met together for *public* worship. These invidious distinctions in a church are most unseemly, especially when they who avail themselves of them are those who are set over the congregation, and whose duty it is therefore to afford an example of fervour and attentive demeanour.

We regret to see that it is publicly stated elsewhere that this building is creditable alike to the taste of the architect, and the munificence of those who contributed the funds. These general commendations can answer no beneficial purpose whatever. The great object of architectural criticism should be the advancement of architecture, and therefore eulogiums of bad architecture (except in newspapers, where their value is pretty well understood) can never be innocuous. We have already praised the external design of the new church, but the interior displays the grossest faults. It has however one good feature which we must not omit to notice. Considering the shallowness of the sacrarium, the absence of a chancel-arch is a matter of commendation. In some modern churches with mere recesses for the communion table, the nave terminates with an enormous chancel-arch, which would be in proportion were there a spacious chancel beyond it, but from the absence of that member appears disproportionate and entirely out of place. These cases are instances of the unthinking retention of forms after the use of them has ceased. It also should be stated that the building has not a show-side—it is a church and not a *church-front*. The architect has avoided the vulgar ostentation of making the most conspicuous side of the edifice the most showy: the eastern side of the church is as much ornamented as the western, although the former cannot be viewed from the public road, and is therefore comparatively inconspicuous.

STEAM NAVIGATION.

We are indebted for the annexed Table showing the proportion of British and American built Steam Ships, to the American *Franklin Journal*, it is taken from a Report of Mr. W. C. Redfield, of New York, U. S., to the President of the Board of Navy Commissioners, dated Dec. 31, 1841.

Of the steam vessels comprised in the table, class A is intended to represent the largest class of war steamers which has yet been constructed; together with the most approved and successful class of ocean steamers now employed in transatlantic navigation; but which, in case of war, will also be employed as steam frigates. Of the former, I have selected the Gorgon, steam frigate, belonging to the British navy, the Kamschatka, lately built in this city for the Russian navy, and probably superior to any war steamer in the navies of Europe; together with the Missouri, from our own navy, superior in size to either of the above named vessels. From the mercantile class of steam ships I have selected the Great Western, and also one of the four Halifax or Cunard steamers, each of these being perhaps superior in relative power of engine, and probably in speed, to the war steamers already mentioned. It is known the four Halifax steamers are alike in all respects.

The medium sized war steamers, or class B, are represented in the table only by the United States steamers Fulton, and the two war steamers lately constructed here on the British plan, for the authorities of Cuba. I do not attach much importance to the results shown in this class.

Class C consists of three American steamers which are employed on coasting routes, viz.—the Narragansett, Neptune and New York; together with the South America, one of the steamers employed on the river Hudson. It is to the qualities of this class of steam vessels that I shall more particularly invite the attention of the Board,—believing as I do, that it promises to be more efficient and useful for naval service and coast defence than any other class.

Class D in the table consists of the steamer *Balloon*, a very light vessel, built solely for the navigation of the upper part of the Hudson, but which has been well proved in her sea-going qualities in rough weather, and has been also employed on Narragansett bay, and on James river; together with the steamer *Gladiator*, which was first employed on the coast routes eastward of this city, but now runs regular trips on the southern coast, between Charleston and Wilmington. This class, I shall attempt to show, is also capable of rendering most important services.

It would have been easy to have added other examples of this and the foregoing classes had it consisted with the size of the table, or been necessary to the immediate objects which were had in view in its compilation.

The English methods of computing the tonnage of steam vessels, not being suited to show the full size or capacity of the vessel, and disagreeing also with American rules of computation, I propose to adopt the following as a rule for obtaining the approximate tonnage, viz:—"Multiply the length between the perpendiculars (reckoned from the rabbets of the stem and stern post at the level of the deck) by the full breadth of the hull at midships, and the product by the central depth from the top of the deck beam to the top of the floor timbers, or of the ceiling thereon: divide this product by 100, by separating the two right-hand figures, and the quotient may represent the conventional, or approximate tonnage."

As the estimated working power of marine engines will doubtless continue to be expressed in *horse power*, and as the power actually obtained in practice, even with like engines, must necessarily be variable, it seems desirable to obtain, also, a ready rule for this estimate and expression, founded on the capacity of the cylinder, or of that portion of it through which the piston moves, at each stroke. I have, therefore, in the construction of the table, adopted a rule founded on this principle, "and have estimated fourteen hundred cubic inches of the capacity aforesaid, as being equal, approximately to the power of one horse." This rule affords results which perhaps correspond more nearly with the working power of English marine engines, than with those which are found in the best American steam vessels.

For my estimate of the actual buoyancy of the several vessels in the table, as compared with their entire weight in line 17, I have taken the immersion of the midship cross section, both at the greatest load and at light load, as being the measure of weight; and the floating area of the same section, from the water line to the top of the beam ends, as being the measure of surplus buoyancy. This method of computation is probably sufficient for the purposes of comparison; although the entire weight or displacement of the vessel as compared with the whole floating capacity between the entire water line and the top of the central beam ends, would show the surplus buoyancy more accurately, and would increase somewhat the comparative buoyancy shown in line No. 17 of the table. The want of room has caused the omission of some other comparisons which might be interesting and useful.

On examining the table it will be seen that a strong contrast is presented i the proportions and other qualities of the steam vessels of the classes A and B, as compared with those of the truly American classes C and D. This contrast is mainly founded on the more bulky proportions and greater weight of the two first named classes.

One of the most important elements of proportion in a steam vessel is the ratio of its length to its breadth; as will appear from considerations to which I have already alluded. In the class A, of frigate build, the proportion of length to breadth, line 22 of the table, is found to be as 5·65 to one: while in class C the proportion in nine to one. The proportion also, of *depth* to both length and breadth, lines 23 and 26, afford us a constrast equally remarkable: while the proportion of *breadth* to the *draft of water*, lines 27 and 28, are no less worthy of our attention.

I do not now propose to examine all the various practical results which are exhibited in the table, nor to point out the many important inferences which may be drawn from the facts here presented; but shall confine myself to a passing notice of some of the chief qualities which appear to claim our attention.

It is well known that the finer proportions and lesser weight of the steam vessels of classes C and D ensure for them a higher rate of speed than can be attained by the vessels of the other classes, even if we allow to the latter, in favourable circumstances, the full aid of sails. Nor can it be doubted that superior speed in ships or war steamers must constitute a chief element of success in naval warfare.

Table of Dimensions and Qualities of British and American Steam Vessels.

No.	SPECIFICATIONS AND PROPOSITIONS.	CLASS A, heavy and frigate built Steamers.					General average of Class A.	CLASS B.		General average of Class B.
		G. Western.	Acadia.	Gorgon.	Missouri.	Kamschatka.		Fulton.	Lion and Eagle.	
1	Length between perpendiculars	212 ft.	206 ft.	183 ft.	220 ft.	210 ft.	206 ft.	181 ft. 6 in.	154 ft.	168 ft.
2	Breadth between paddle boxes	35 ft. 4 in.	34 ft. 4 in.	37 ft. 6 in.	40 ..	38 ft. 10 in.	36 ft. 10 in.	34 .. 6 ..	30 ft. 8 in.	32 ft. 7 in.
3	Depth of hold	23 ft. 2 in.	22 .. 6 ..	23 ..	23 ft. 6 in.	24 .. 6 ..	23 .. 4 ..	12 ..	14 .. 8 ..	13 .. 2 ..
4	Dividing angle of the bow at deep load line ..				63° (31½° ea. side)			56° (28°)		
5	.. .. at the deck				75°	70°		68°		
6	Entire weight with full load, (chiefly estimated) ..	2196 tons.	2107	2262	2836	2400	2360	1320	953	1136
7	Measured tonnage, as per rule offered	1735 ..	1591	1571	2068	1907	1776	750	650	700
8	Horse power of engine, as per rule offered ..	516	408	304	517	476	444	302	156	229
9	Draft of water at common or light load ..	13 ft.	14	13 ft. 9 in.	15 ft. 6 in.	14 ft. 6 in.	14 ft. 3 in.	11 ft.	8 ft. 3 in.	9 ft. 9 in.
10	.. with fuel and stores for 1000 miles route							12 .. 2 in.	10 ..	11 ..
11	.. .. .. 3000	17 ft.	17 ft. 3 in.	18 ft. 6 in.	19 ft.	18 ft.	18 ft.		12 ..	
12	Height of deck line (top of midship beam ends) above water, at greatest load	8 ft. 6 in.	7 .. 6 ..	7 ..	8	8 .. 8 ..	8 ..	2 ft. 4 in.	4 .. 7 ..	3 ft. 6 in.
13	Depth of centre of gravity of displacement of midship cross section at full load	7 ..	6 .. 1 ..	7 .. 2 in.	7 ft. 2 in.	6 .. 8 ..	7 ..	5 .. 4½ in.	4 .. 5 ..	4 .. 11 ..
14	Area of deep load line, or water surface covered by the vessel	6420 ..	6063	5882	7540	6633	6507	5024	3785	4493
15	Area of midship cross section, immersed at greatest load	481 ..	487	535	618	488	522	354	285	329
16	.. .. .. common or light load	341	375	390	468	337	386	320	187	253
17	Buoyancy to entire weight at full load (reckoning at top of beam ends midships)	1·6 to 1	1·5 to 1	1·5 to 1	1·5 to 1	1·66 to 1	1·55 to 1	1·26 to 1	1·5 to 1	1·38 to 1
18	Bouyancy to entire weight at common or light load ..	2·26 .. 1	2 .. 1	2 .. 1	2 .. 1	2·2 .. 1	2·09 .. 1	1·26 .. 1	2·2 .. 1	1·73 .. 1
19	Proportion of measured tonnage to horse power ..	3·36 ton .. 1 h.p.	3·9 .. 1	5 .. 1	4 .. 1	4 .. 1	4·05 .. 1 h. p.	2·48 .. 1	4·16 .. 1	3·32 .. 1
20	.. to each ft. of immersed cross sec., full load	3·6 .. 1 ft.	3·3 .. 1	3 .. 1	3·34 .. 1	3·9 .. 1	3·48 .. 1 ft.	2·1 .. 1	2·3 .. 1	2·2 .. 1 ft.
21	.. .. : .. light	5 .. 1 ..	4·2 .. 1	4 .. 1	4·4 .. 1	5·3 .. 1	4·6 .. 1	2·34 .. 1	3·5 .. 1	3·42 .. 1
22	Proportion of length to breadth	6 to 1	6 .. 1	4·9 .. 1	5½ .. 1	5·84 .. 1	5·65 .. 1	5·22 .. 1	5·4 .. 1	5·3 .. 1
23	.. depth of hold	9 .. 1	9 .. 1	8 .. 1	8¾ .. 1	8½ .. 1	8¾ .. 1	15 .. 1	18½ .. 1	13 .. 1
24	.. draft of water at full load ..	12½ .. 1	11·6 .. 1	10 .. 1	12 .. 1	12 .. 1	11·6 .. 1	15 .. 1	13 .. 1	14 .. 1
25	.. .. light load ..	16 .. 1	14 .. 1	13 .. 1	14 .. 1	14 .. 1	14 .. 1	15 .. 1	19 .. 1	17 .. 1
26	.. breadth to depth of hold ..	1·5 .. 1	1·5 .. 1	1·7 .. 1	1·7 .. 1	1·5 .. 1	1·6 .. 1	2·9 .. 1	1·8 .. 1	2·3 .. 1
27	.. to draft of water at full load	2·07 .. 1	2 .. 1 nearly	2 .. 1	2·1 .. 1	2 .. 1	2·07 .. 1	2·9 .. 1	2·4 .. 1	2·68 .. 1
28	.. .. .. light load	2·7 .. 1	2·4 .. 1	2·1 .. 1	2·7 .. 1	2·5 .. 1	2·5 .. 1	2·9 .. 1	3·4 .. 1	3·1 .. 1
29	Area of bearing surface (No. 14) to measured tonnage	3·7 ft. to a ton.	3·8 .. 1	3·7 .. 1	3·6 .. 1	3·5 .. 1	3·66 ft. to 1 t.	6·7	5·8	6¼ .. 1
30	.. to entire weight at full load ..	3 ..	2·87 .. 1	2·6 .. 1	2·65 .. 1	2·76 .. 1	2·77 .. 1	3·[illegible]	4	3·9 .. 1
31	.. to area of immersed cross sec., at full load	13·3 to 1	12·5 .. 1	11 .. 1	12·2 .. 1	13·6 .. 1	12·5 .. 1	14·2 .. 1	13½ .. 1	13·72 .. 1
32	.. .. at light	·18 .. 1	16 .. 1	15 .. 1	16 .. 1	18 .. 1	16·6 .. 1	15·7 .. 1	20 .. 1	17·8 .. 1
33	.. .. to horse power of engine	10½ ft. to 1 h. p.	15 .. 1	19 .. 1	14½ .. 1	14 .. 1	14·6 .. 1 h. p.	16·6 .. 1	24 .. 1	20 .. 1
34	Horse power to each foot of immersed cross section, ... at full load	1·07 h.p. to 1 ft.	0·84	0·57	0·85	0·97	0·86	0·85	0·55	0·7 .. 1
35	.. .. .. at light load	1·5 .. 1 ..	1·06	0·78	1·1	1·3	1·15	0·94	0·83	0·86 .. 1
36	Estimate of coal used per hour with full fires ..	1½ tons.	1 ton 3 cwt.	1 ton.	1¾ tons.	1¼ Ton.	1¼ Tons.	1½ ton.	½ ton.	1 ton.
37	Estimated average speed at full load	8½ miles.	8½	8	8	8½	8½ miles.	11	8	9¼ miles.
38	Comparative efficiency of movement at this speed ..	72	72	64	64	72	68·8	121	64	92
39	Estimated average speed at light load	12 miles.	12	11	11	11½	11½	11½	11	11¼
40	Comparative efficiency of movement at this speed ..	144	144	121	121	132	132	132	110	121
41	Diameter of cylinder in inches	Two 74 in.	Two 72	Two 64	Two 62	Two 60	Two 66½ in.	Two 50 in.	Two 42½	Two 47
42	Length of stroke	7 ft.	6 ft. 10 in.	5 ft. 6 in.	10 ft.	9 ft. 10 in.	7 ft. 10 in.	9 ft.	4 ft. 7 in.	6 ft. 9 in.

No.	SPECIFICATIONS AND PROPOSITIONS.	CLASS C.				General average of Class C.	CLASS D.		General average of Class D.
		Neptune.*	Naragansett.	South America.	New York.		Balloon.	Gladiator.	
1	Length between perpendiculars	221 ft.	212 ft. 6 in.	250 ft.	230 ft.	228 ft.	160 ft.	190 ft.	175 ft.
2	Breadth between paddle boxes	25 ..	27 ..	27 ..	23 ..	25 ft. 6 in.	18 ..	22 ..	20 ..
3	Depth of hold	13 .. 6 in.	10 .. 4 .. light load line.	9 .. 3 in.	11 ..	11 ..	7 .. 6 in.	9 ft. 3 in.	8 ft. 3 in.
4	Dividing angle of the bow at deep load line		25° (12½° ea.)	15° 7½° each.					
5	.. .. at the deck		deep 30°	23° 11½° each.	32½° 16¼° each		28°		
6	Entire weight with full load, (chiefly estimated) ..	645	654	521	495	580	206	430	318
7	Measured tonnage, as per rule offered	745	596	624	582	637	216	387	301
8	Horse power of engine, as per rule offered	193	242	216	181	208	58	130	94
9	Draft of water at common or light load	6 ft. 6 in.	6 ft. 6 in.	5 ft.	4 ft. 9 in.	5 ft. 8 in.	4 ft.	6 ft.	5 ft.
10	.. with fuel and stores for 1000 miles route	7 .. 6 ..	7 .. 6 ..	6 ..	6 ..	7 .. ¼	5 ..	6 ft. 9 in.	6 ..
11	.. .. .. 3000								
12	Height of deck line (top of midship beam ends) above water, at greatest load	7 .. 9 ..	5 ..	5 ft. 3 in.	6 ft. 9 in.	6 ft. 2 in.	4 ft. 3 in.	4 ft. 6 in.	4 ft. 5 in.
13	Depth of centre of gravity of displacement of midship cross section, at full load	3 .. 1 ..	3 .. 1 in.	2 .. 6 ..	2 .. 7 ..	2 .. 10 ..	2 .. 4 ..	2 .. 6½ ..	2 .. 5 ..
14	Area of deep load line, or water surface covered by the vessel	4125 ft.	4218	4528	3850	4180	2160	2984	
15	Area of midship cross section, immersed at greatest load ..	154	166	134	115	142	72	111	91
16	.. .. .. common or light load	130	140	108	93	118	54	95	74
17	Buoyancy to entire weight at full load (reckoning top of beam ends midship)	2·26 to 1	1·81 to 1	1·86 to 1	2·5 to 1	2·11 to 1	1·8 to 1	1·8 to 1	1·8 to 1
18	.. .. at common or light load	2·67 .. 1	2·3 .. 1	2·85 .. 1	2·91 .. 1	2·68 .. 1	2·25 .. 1	2 .. 1	2·12 .. 1
19	Proportion of measured tonnage to horse power ..	3·8 .. 1	2·46 .. 1	3 .. 1	3·2 .. 1	3·1 .. 1	3·7 .. 1	3 .. 1	3·4 .. 1 h. p.
20	.. to each foot of immersed cross sec., full load	4·8 .. 1 foot.	3·6 .. 1	4·6 .. 1	5 .. 1	4·5 .. 1	2·86 .. 1	3·5 .. 1	3·18 .. 1 foot.
21	.. .. light	5·7 .. 1	4·2 .. 1	5·8 .. 1	6·2 .. 1	5½ .. 1	4 .. 1	4 .. 1	4 ton to 1
22	Proportion of length to breadth	9 .. 1 nearly	8 .. 1 near.	9½ .. 1	10 .. 1	9 .. 1 near.	9 .. 1 near.	8·7 .. 1	8·9 .. 1
23	.. depth of hol	16 .. 1	20½ .. 1	27 .. 1	20 .. 1	21⅙ .. 1	21 .. 1	20·6 .. 1	20·8 .. 1
24	.. draft of water at full load ..	29½ .. 1	28 .. 1	36 .. 1	38 .. 1	33 .. 1	32 .. 1	28 .. 1	30 .. 1
25	.. .. .. light load ..	34 .. 1	32½ .. 1	41½ .. 1	48 .. 1	39 .. 1	40 .. 1	32 .. 1	36 .. 1
26	.. breadth to depth of hold	1·9 .. 1	2·6 .. 1	3 .. 1 near.	2 .. 1	2·4 .. 1	2·5 .. 1	2·4 .. 1	2·5 .. 1
27	.. .. to draft of water at full load ..	3½ .. 1	3·6 .. 1	4½ .. 1	3·8 .. 1	3·8 .. 1	3·5 .. 1	3·3 .. 1	3·4 .. 1
28	.. .. light load ..	4 .. 1 nearly	4 .. 1	5·4 .. 1	4·8 .. 1	4·5 .. 1	4½ .. 1	3·6 .. 1	4 .. 1
29	Area of bearing surface (No. 14) to measured tonnage ..	5·5 .. 1	7·8 .. 1	7·3 .. 1	6·6 .. 1	6·8 .. 1 ton.	10 .. 1	7·58 .. 1	8·8 .. 1 ton.
30	.. to entire weight at full load ..	6·4 .. 1	6·6 .. 1	8·7 .. 1	7·8 .. 1	7·4 .. 1 ..	10·7 .. 1	7 .. 1	8·8 .. 1
31	.. to area of immersed cross section full load	27 .. 1	25·6 .. 1	34 .. 1	33 .. 1	30 .. 1	24 .. 1	26 .. 1	25 .. 1
32	.. .. light load	32 .. 1	30 .. 1	42 .. 1	41 .. 1	36 .. 1	30 .. 1	31 .. 1	30½ .. 1
33	.. to horse power of engine	21 .. 1	17 .. 1	21 .. 1	21 .. 1	21 .. 1 h. p.	37 .. 1	23 .. 1	30 .. 1
34	Horse power to each ft. of immersed cross sec. at full load	1·2 h. p. to 1 ft.	1·46 .. 1	1·61 .. 1	1·6 .. 1	1·47 .. 1 foot	0·8 .. 1	1·17	1 h. p. to a foot
35	.. .. at light load	1·4 .. 1 ..	1·7 .. 1	2 .. 1	2 nearly.	1·8 .. 1	1·07 .. 1	1·38	1·22 h. p. to a ft.
36	Estimate of coal used per hour with full fires	1½ ton.	1½ ton.	1 ton.	1 ton.	1¼ ton.	10 cwt.	15 cwt.	12½ cwt.
37	Estimated average speed at full load	12	12	13	13	12½ miles.	12	12½	12½ miles.
38	Comparative efficiency of movement at this speed ..	144	144	169	169	156	144	156	150
39	Estimated average speed at light load	14	14	15	15	14½ miles.	14 miles.	14½	14¼
40	Comparative efficiency of movement at this speed ..	196	196	225	225	210	196	210	203
41	Diameter of cylinder in inches	50 in.	56 in.	54 in.	52 in.	53 in.	28 in.	42	36 in.
42	Length of stroke	11 ft. 6 in.	11 ft. 6 in.	11 ft.	10 ft.	11 ft.¼	11 ft.	11 ft.	11 ft.

ON RUSTICATION.

By Candidus.

Taking at his word the writer who has just decried Rustication as being no better than the counterfeit of deformity; and believing, or at least pretending to believe, him sincere when he declares his willingness "to be set right," I purpose to do so—at any rate, to make it apparent to others that he has been setting them wrong,—to expose the futility and one-sidedness of his objections, and to convict him either of great intolerance in some matters, or of great inconsistency in tolerating in others what may have similar objections may be enforced against with equal plausibility. That Rustication is most decidedly expressive of stonework construction, and that it renders the articulation of masonry more *prononcé*, is not to be denied. Buildings are not supposed to be *extructed* or carved out of solid masses, they being known to consist of separate stones put together in courses; wherefore there can be no impropriety—nothing irrational in permitting such compaction and bonding to declare itself* to the eye, and become a mode of decoration for the general surface of the walls, which, accordingly as it is treated, may be expressive chiefly of rude strength and energy, or of finished elegance and elaborate symmetry. While it is so uniform that it does not at all cut up the surface and distract the eye—therefore, is not destructive of simplicity—it gives the surface richness, crispness, and colour, and forms a ground that greatly relieves pilasters and other architectural members, causing them to appear more distinct. So far from deserving to be stigmatized as a deformity or studied counterfeit of it, Rustication appears to me to be perfectly legitimate and æsthetic—at least in itself, for like everything else, it may be made to minister to bad taste as well as to good.

One formidable argument levelled against Rustication, and intended to operate as a complete demolisher, is that it was not practised by the Greeks; at least, not at the best period of their Doric style. Yet what then?—are we at once to condemn, without further inquiry, everything that does not accord with Greek practice? Is it pretended to be affirmed that the Greeks, who contented themselves with just one or two ideas in their temple architecture, so completely exhausted all the modes of beauty, and all the resources of design available for any similar style, as to leave us no other alternative than either doing precisely as they did, or plunging into deformity? Because severe simplicity was the character of the Parthenon, is it to be that of every other structure? Are critics to be allowed to make use of the Parthenon for ever as a bed of Procustes, by which they take measure of every building, lopping off from the unlucky one which has fallen into their clutches, whatever of it exceeds that infallible standard of excellence? The Parthenon was, unquestionably, most exquisite both as to material and execution, as it was constructed of large blocks of white Pentelic marble, so admirably wrought that the jointings of the masonry were imperceptible. But to that kind of beauty our buildings may not aspire—we have neither the marble nor the climate of Greece. Our best ashlar stone-work will not retain perfect uniformity of tint and surface, and even were it to do, and could it be so wrought that the masonry joints would not at all be seen, the effect, it may be presumed, would be no other than that of good stucco,—of course more durable, but no better in appearance than the other, so long as the stucco remains in good condition. It is, therefore, an advantage that we are enabled by means of Rustication to turn the masonry jointings to account, and to produce a different species of regularity and beauty of surface.

If we are to abide by Grecian architecture alone, and to reject all that has been added to or engrafted upon it, only as so many corruptions of it, we ought not only to protest against Roman and Italian architecture, but ought to abandon the study of them, lest we should catch infection from them. The Florentine style more especially must be held in aversion by those who perceive neither grandeur, vigour, nor any other merit in Rustication, but only unqualified deformity, and what the writer whom I am trying "to set right" is pleased to brand by the intended-to-be-ignominious terms of "tatooed masonry" and mere "surface decoration." He will have it that "as soon as chamfered masonry is introduced, all simplicity is lost at once, each stone assuming a separate individuality;" yet, as it appears to me, he might just as well maintain that a striped dress is inconsistent with perfect simplicity of attire; or—to keep to architecture—that a striped—in other words, a fluted—column is contrary to simplicity and is a barbarism, a shaft so decorated being in fact neither more nor less than "tatooed," while each of the fillets "assumes a separate individuality;" and the beautiful rotundity of the shaft itself being greatly impaired by such unlucky "surface decoration." Even the Greeks themselves then, it would seem, were not altogether infallible; and besides being at variance with what appear to be some persons' notions of true simplicity, what meaning is there in the fluting of a column?—what does it express?—most assuredly nothing constructional, whereas Rustication does. It has been supposed by some that the first idea of fluting was derived from fissures in the shafts of wooden columns, or from channels worn by the rain on the surface of stone ones,—an hypothesis, however, that must henceforth be rejected with scorn, because it would make out the Greeks to have been guilty of such very bad taste as to condescend to counterfeit defects and deformities, which would have been an inexcusable enormity, notwithstanding that so counterfeited what were originally defects became beauties. There were very strong æsthetic reasons—too generally known to require to be stated here—which induced the Greeks to adopt the practice of fluting, if such term be not "too dignified" for the scoring produced by "mere streaks," and for the absurdity of covering the shafts of columns "*all over* with mouldings."

May not the deep channels employed for the flutings of Ionic and Corinthian columns be reproachfully described by the terms "gashes" and "incisions," with just as much fairness as the channelled joints of rusticated masonry? Difficult it surely would not be for any one so disposed to get up—upon paper—a pretty strong case against the practice of fluting columns as an unmeaning one at the best, as one at variance with simplicity, and partaking more of disfigurement than of embellishment.

It is contended by the writer who has laboured to prove—and who, no doubt, fancies that he has clearly proved, both the irrationality and bad taste manifested by Rustication—that when employed together with columns, the horizontal channels appear to cut athwart the shafts of the latter and "destroy that idea of verticality which is their essential attribute;" of which injurious effect, he quotes the peristyle of La Madeleine as an instance. Now, had he chosen to say that the columns appear to cut athwart the horizontal lines of the rusticated wall behind them, he might have done so in welcome, and have made out of that circumstance as much as he could for argument against Rustication; but as he did not do so, it is for him now to make out how the columns appear to be cut through by lines which they themselves cut by interrupting and intercepting. It is, therefore, rather the idea of *horizontality* as expressed by the courses of masonry is destroyed, than that of *verticality*, which latter is rendered all the more evident by the direct contrast between horizontal and vertical lines so produced. But of the value of contrast the critic who has detected such equally unlucky and curious appearance in La Madeleine seems to have no idea. Fortunate, therefore, is it for the credit of the Grecian-Doric style itself that it is protected by the ægis of classical precedent and authority, else were it ever to suit his immediate purpose to do so, the same writer would probably not scruple to censure as an absurdity the intermixture of triglyphs and sculpture in the Doric frieze. With far greater plausibility of argument than he has now used, he might urge that if sculpture is to be introduced, the triglyphs ought to be dismissed; or if the latter must be retained, the metopes ought to be left plain, since sculpture and triglyphs together mutually destroy each other's effect, and produce a most unsatisfactory jumble the very reverse of simplicity. Instead of being kept continuous, the sculpture, it might be argued, is cut up into bits and fragments; each piece of it assumes a separate individuality, and really appears to be "set in a frame;" besides which, the sculpture of course seems to cut the triglyphs themselves athwart, precisely in the *same manner* as the rustic joints on a wall *behind* columns cut athwart the columns in front. After being so exercised, criticism might descend—might stoop down to examine the steps of Greek Doric temples, and attack with ridicule the deep moulded channel cut below in the front of each of them, as being a marked defect, and causing the steps to appear undermined and weakened. To be sure, those grooves contribute to æsthetic effect; and if that be sufficient excuse for what, if now done for the first time, would be reprobated as a caprice, excuse may be extended to other cases.

Having pointed out circumstances in pure Greek architecture, upon which the same sort of captious hypercriticism might be brought to bear which protests so peevishly against Rustication, we follow the writer's remarks, and next find him just after observing that the sunk-channels in Rusticated work cannot be received as "mouldings"—and who has ever called them such?—talking of the absurdity of a building "all over mouldings;" so that in one and the same breadth, he denies and admits them to be equivalent to mouldings. As to confusion being produced by so many lines of that kind on a building—that may be left to contradict itself—is,

* The reader will excuse the singular or can substitute the plural number for it.

in fact, strongly contradicted by the exterior of Newgate, which is characterized by breadth of surface, but which, had it not been Rusticated, would have been comparatively an insipid blank; although admirably combined in its general composition, in which respect it fulfils a condition which the writer in question has made a very stringent one, although it is frequently quite impracticable. "It may be safely asserted," he says, that no buildings, whatever may be the style adopted, can be architecturally effective unless some portions of the building throw shadows on the remainder." No doubt, bold relief and chiaroscuro contrasts are highly valuable and impart unwonted spirit and energy to a composition; and the same distribution of projecting and receding parts which produces shadow, produces also great variety of perspective effect. Yet, except in some few cases, how is it possible to plan town buildings so as to obtain the requisite breaks for the purpose in the general line of frontage? Of what can street architecture chiefly consist if not of what so greatly excites the writer's positive indignation, viz., "show fronts" towards the street, and "surface decoration" upon them,—terms which are quite favourite and pet ones with him, and invariably intended to be eminently reproachful? If, without regard to its merits in what it does show, we are to be dissatisfied with every building that does not stand quite insulated, and so as to show itself on every side,—if that is to be made a *sine qua non*, we must be prepared for being very much out of humour for a very long while to come. There is no help for it; so let us console ourselves by fairly damning modern architecture altogether, as our philosophical writer appears disposed to do himself, and, if he can, to prevail on others to do so likewise.

We cannot, however, afford to damn it just yet, because we have not yet quite done with Rustication.—Rough rubble-work, we are told—not that there was much occasion for the information,—would be unfit for the cella of a Greek temple, because "the coarseness of the workmanship would be quite out of character with the rest;" and by this it is intended to be insinuated that every mode of Rustication must be equally unsuitable for the same style. Is there then, I ask, no distinction of character between rubble-work and rusticated masonry?—none between the coarse workmanship and rough surface of the one, and the uniform regularity and elaborate workmanship of the other? This difference—which striking as it seems, the writer does not perceive, or else wilfully shuts his eyes to it,—goes very far towards answering what he says when he calls upon those who would defend Rustication, to point out wherefore, if unexceptionable in itself, such mode of masonry should not be equally proper for buildings in the Pointed as in the Classic style. He affects very innocently to wonder what can possibly be "the characteristic differences between the two styles," that they require, at least admit of, different modes of masonry for them, just after he had himself said that rubble-work would be incongruous in a Grecian edifice. If Rustication is to be held illegitimate, and to be renounced because it does not become all styles alike, the irregular masonry of the stonework in Gothic buildings, together with brickwork, flintwork and rubble, may be all set down as vicious and absurd, unless it can be shown that they are just as appropriate for the Classic as in the Pointed and Old English styles. As well might we be told we ought to be "prepared to adapt" flutings to columns in the Pointed style as well as in the Classic, or else abandon such decoration altogether.

The difference of character between the two styles, or rather the two distinct architectural *races*, is so great that hardly any one except the writer whose opinions and dicta I am controverting, would propose to reject Rustication because though it accords with the idiom and practice of the one style, it is contrary to the practice, and therefore to the idiom of the other. Had rubble-work been used in classic buildings, it would have belonged to the classic idiom of the art; and in like manner had that species of masonry which is distinguished by the term Rustication been practised by the mediæval architects, it would have been incorporated with the rest of their system of design, and would have become idiomatic and characteristic. Separate styles have, like separate languages, their respective idioms and peculiarities; but though peculiarities widely differing from each other, it does not follow that they are therefore contrary to those universal and catholic principles which apply to all styles of the art alike. In architecture a very great deal is purely conventional, and might be applied indifferently were it not that custom has stamped such or such particular mode as belonging to a particular style, as being a part of its *costume*, consequently proper to that, though in any other it might show as a decided impropriety. Possibly, therefore, it will still be pertinaciously maintained, that Rustication is foreign to pure Grecian architecture—a departure from its costume: true; but it is Roman, and so far legitimately antique and classic, quite as much as the Roman, or what we call the Corinthian, order itself. And if the *Romanism* which so decidedly pervades La Madeleine in all other respects be not objected to, wherefore should its Romanism in regard to Rustication and the "surface decoration" of its walls be condemned as nothing less than a barbarism at variance with all classical precedent? If we ought henceforth to abide strictly by pure Greek architecture, just as it was practised by the Greeks themselves in such temples as the Parthenon, without presuming to adopt into it innovations of any kind—not even those which have become to ourselves rather *archaisms* than innovations, let us be told so explicitly; but let those who would enforce such doctrine, keep to their own bond. Let them reject and discard all and every thing that is at variance with Grecian practice and costume—that is, the costume of Greek temples, almost the only class of Greek buildings which we are sufficiently acquainted with to be able to judge of them correctly as a class,—and then perhaps they will discover to what exceedingly limited resources they will have restricted architecture; yet whether even then all of them would actually confess as much. may be questioned, for some of them might feel far more exultation in having gained their own point, than any sort of concern for the consequences to architecture itself. And this seems to be the case with some who not having any real affection for the art, seem to regard it only as a very good subject for them to discourse and debate about, more or less fluently, caring for little else than displaying their own expertness in logomachy. One characteristic of such critics and criticism, is that bigotted intolerance which peremptorily decides every thing to be wrong which differs from their own exclusive standard of what is excellent and right;—nor is it at all difficult to make it appear to those who are content to look merely at one side of a question, and take up with a decisive and seemingly firmly settled opinion without further trouble to themselves,—that whatever deviates from such standard must of course be wrong.

My opponent—at least, the writer to whom I have here presented myself as an opponent, is certainly most intolerant of Rustication, for he insists that it is absolutely intolerable—a gross abuse and absurdity that ought to be no longer tolerated by us at all, nor any longer be recognized as a mode of decoration to which the architect can have recourse on suitable occasions. How greatly I differ from him is sufficiently attested by this vindication of Rusticated masonry,—which, indeed, I could wish to see more frequently and more effectively made use of among us than it now is. I am very far, however, from intending to recommend it as an infallible *nostrum*, or as what ought to be applied in all cases. Rustication may be well or ill-applied; may be either very good of its kind, or very bad; yet the bad is so far from justly discrediting the good, that it rather adds to the merit of the latter. Were not such the case, some of our modern specimens of it would long ere this have brought "*pure* Classic architecture" into utter discredit among us, they being far more deserving of "detestation" than that "*debased* Classic architecture" which had openly revolted from Classic precedent, had thrown off allegiance from it, and had rendered itself independent of it.

FENESTRATION AND WINDOWS.

Audi Alteram Partem.

Although another writer has in the interim taken up the subject of the Decoration of Windows, and given his opinions upon it, especially as regards the employing columns for such purpose, that is so very far from frustrating the intention hinted at by us in a note (page 130), in the article on the Fitzwilliam Museum, by forestalling what we meant to say, as rather to stimulate us to take up our pen without further delay. Having thus apprized the readers of this Journal that the remarks, in the May number, on the building just mentioned, proceeded from ourselves, we may be permitted to confess our surprise at finding, the following month, a second paper on the Fitzwilliam Museum, denying it all those particular merits as a piece of architecture, which had been claimed for it by ourselves. Had that second article distinctly announced itself to be the production of a second writer, and intended to reply to and correct the criticism that had just before appeared, the sort of mystification that must now have been occasioned by it would have been avoided. Strangely enough, it did not even take the slightest notice of what had been previously said,—no more than if nothing had been said at all, at any rate nothing more than a mere account of the building, without any criticism upon it. Admiration was still professed;

only it was made out after all that every thing in it which had been especially admired just before, was naught, and that the design would have been infinitely better, were it almost the reverse of what it is; wherefore we may consider is fortunate for us that what we had said was not formally contradicted and cut up. Tardy as it is, this explanation is due both to ourselves and to the Journal,*—for the latter not undesirable, since it exculpates it from what must have looked like inconsistency.

We are very far from wishing—to say the truth, have more conceit of ourselves than to desire that opinions which militate against our own should be suppressed; and we only claim in return that ours be not suppressed, because they happen not to accord with those of other persons. Differ we most assuredly do very strongly, both from the author of the article "On the Employment of Columns and Pediments as Window Mouldings,"—(*mouldings* seems a term very oddly applied to columns),—and from Dr. Fulton,—who has mistaken a ludicrously droll and whimsical comparison for argument *ad absurdum* against window pediments, and has flourished it about accordingly for the purpose of intimidating those who allow themselves to be scared by words and nicknames. But before we begin to speak of windows themselves, it may be as well to say something on "Fenestration" generally,—its influence on design and composition, and the characteristic physiognomy occasioned by it. Rather strange to say, it is one of those subjects which so far from being taken up are scarcely even approximated to in architectural "treatises," and didactic writings of that kind; and when it has been touched upon elsewhere, it has been only *aslant*, and to fly off from it again in a tangent. While of speaking of columns there has been no end, hardly a word has been uttered as to the essentials and conditions of *Columniation*; and in like manner, instruction with regard to windows is confined to a few ordinary matter-of-fact rules—without anything being said of *Fenestration* as a system. Nevertheless that and Columniation are two such decidedly distinct systems, that buildings now classed together as belonging to one general style might properly enough be further distinguished accordingly as they belong to, or most partake of the one or the other of the two different modes. Neither are the two systems merely different forms, but hostile and repugnant to, and almost incompatible with each other. They conflict so obstinately—what is required by the one is so strongly opposed to what is demanded by the other, that scarcely any treatment, however dexterous, can effectually reconcile them, or effect more than a tolerable compromise.

That windows are totally at variance with the effect attending genuine antique columniation, whose columns are backed by a continuous surface of wall, unbroken by openings for admission of light, is indisputable. If not destructive of beauty, they are destructive of the effect—associated with ideas of classical taste—which results from their absence. Wherefore it generally happens that the more ambitiously and rigorously classical purity of style is aimed at in all other respects, columniation included, the more offensive and incongruous does fenestration show itself. It avails not to say that it is matter of sheer necessity,—that windows there must be, unless the building—however else it may be divided within—has no division of floors, in which case it may be best of all lighted through ceilings and roof. If such unavoidable necessity sufficiently excuses the fenestration, it at the same time condemns the practice of mixing up that and columniation for the nonce, when it is, or to be, known beforehand how greatly the effect of the latter must be impaired by the former. That very necessity which is pleaded by way of apology, ought to be sufficient argument against a style which, however scrupulously copied in regard to matters of mere detail and mechanical execution, must be violated altogether in what constitutes its genuine and peculiar physiognomy. The necessity for numerous apertures in the walls for windows proves that a *pure* Greek style is not the one for us at the present day, it being only in very rare cases, and under peculiar circumstances that it can be adhered to with tolerable fidelity and consistency. Quite idle is it to point out to us the Parthenon as if it were a model expressly fitted for modern purposes. At any rate it ought at the same time to be pointed out also that the *sine qua non* condition of being faithful to its Doric *idiom*, as well as to individual forms of detail, should be observed and attended to.

In such modern structures as the Walhalla near Regensburg, and the Madeleine at Paris, which being lighted within entirely from above, could therefore be made peristylar externally, without any intermixture of windows, the simple dignity of columniation and the repose which ought to accompany it, can easily enough be kept up. So also is it when columniation in the form of portico or colonnade is employed for embellishing that side of a building, where windows can be dispensed with, as is the case with the façade of the Berlin Museum, the Fitzwilliam Museum, and the East or principal front of St. George's Hall, Liverpool.

Fenestration and Columniation are two modes of architectural composition, requiring such very different treatment, and productive of such opposite character, that they mutually neutralize the good effect which each might be made to ensure separately. What would be well proportioned and dignified as an *astylar* front, becomes almost inevitably more or less discordant, and out of character as the background to any colonnade whose pillars are erected in advance of it. Either the colonnade itself has the look of being an afterthought, an addition—whether made for convenience sake, or for mere ostentation,—to what was or ought to have been complete without it. On the other hand, the main structure itself looks as if it had been erected behind a previously existing range of columns, originally belonging to an edifice very differently constituted. While the columns seem as much to encumber as to adorn the front behind them, certainly not to belong to it by evidently growing out of the general organization, the windows—be they ever so unexceptionable in themselves, become blemishes, inasmuch as they cut up the general composition, nay, the graceful simplicity of a colonnade, and contradict the would-be-classical taste which is affected by merely sticking up a few classical columns. Many preposterous instances of the kind are to be met with in the buildings erected some few years ago when we were in the heyday of our *Greekomania*. Of such *examples* we might mention scores, but will content ourselves with one—nor is it by any means the worst, viz., the Law Institution in Chancery Lane, which exhibits the front of a Greek Ionic tetrastyle in antis temple, stuck up before one that is totally different in costume, filled in with windows—it being houselike, and therefore positively undignified, intimately associated as it is with what reproaches it for being homely and dowdy. Well is it, perhaps, therefore that columns cannot kick, or they would frequently be tempted to kick down what stands just behind them.

In fact so far from being at all fit to become yoke-mates, Fenestration and Columniation pull in such contrary directions as to leave only a choice of inconveniences. One of them may be good, or the other may be good, but hardly can both be rendered so or if it be attempted, the result is likely to be that both the one and the other, will prove on a par by being equally unsatisfactory. While good Fenestration requires wide spacing, good Columniation requires just the reverse, otherwise it is attended with a look of meagreness and meanness—the very same defects that are produced by close spacing or *pycnostyle* disposition of the piers between the windows in Fenestration. If there are windows in a wall behind a range of columns, corresponding with the intercolumns, harmony requires that those openings should partake of the proportions of the intercolumns themselves, that is, be very narrow and lofty, and even then such openings will appear crowded together and be destructive of all breadth of surface and repose behind the columns, they being confined to the alternate intercolumns, as is the case in the portico of the Chambre des Deputés at Paris, which consists of twelve columns in front, consequently eleven intercolumns, but has only five apertures (doors) in its background. Therefore in that example—and we are not aware of any similar one, the two different systems are admirably reconciled, and for each the particular mode of spacing which it demands, is duly observed:—a merit which, remarkable as it is, has never before been pointed out by any of those who have spoken of that façade,—not even by Woods himself.

In some cases the Gordian knot has been attempted to be cut by putting the columns in pairs, thereby obtaining great width for the intercolumns, and the breadth of two columns and a half between them. Yet although this obviates the inconvenience of thick set windows and narrow piers, it is objected to as an impropriety—by architectural puritans at least, who will have it to be a downright solecism, because not sanctioned by classical *precedent*; which is surely being over scrupulous and hypercritical, for where can they find precedent for windows at all within a Greek or Roman colonnade? If they can tolerate the one innovation, they have no right to be very much scandalized at the other.

One not unusual mode of getting over the difficulty—at least so it seems to be thought—and obtaining sufficiently narrow intercolumniation, at the

* There was a signature attached to the second article on the Fitzwilliam Museum, which would plainly have distinguished it, as coming from another writer, but it happened, most unfortunately, to be omitted by the printer.—Ed. C. E. and A. Journal.

same time avoiding disagreeable narrow proportions for the piers between the windows, is to adopt a *macrostyle* order for the colonnade, including two floors of the building behind it, and two series of windows. Consequently these latter become small openings, in height at least, as compared with the columns, and by their frequency tend still more than ever to cut up and disturb the surface behind the columns. While greatness is affected by the order, littleness—comparative littleness at least, is expressed by the fenestration, and the inner wall assumes a most unlucky resemblance to an astylar composition, in whose physiognomy Fenestration is intended to predominate, and from which Columniation is intended to be excluded; so that while the windows are a sad drawback upon the pomp and classical style affected by the order, the order itself serves chiefly to put us out of conceit with the Fenestration.

Your Pecksniffs, indeed, get over the difficulty very easily by making no difficulty of it at all. They merely make so many holes for the windows, which being left quite bare of dressings, are not to be considered as belonging or intended to belong to the *architecture* at all: the columns are the things to be looked at; the windows to be overlooked. Yet would it not be far more economic and answer the purpose just as well, to leave it to the imagination to put *in* columns, in the same manner which it is now called up to put *out* windows, by fancying them away?

All things considered, if an order must be employed in conjunction with Fenestration, the best way perhaps, is to make use of it avowedly as decoration, either with pilasters or attached columns, so that the intercolumniation can be regulated according to, or rather accommodates itself without further difficulty to the spacing which is most suitable for the windows; without occasioning that straggling look which would attend a colonnade whose pillars were at the same, or any thing near the same intervals apart. There is at least a certain degree of compactness and solidity attending such intimate combination of columnar architecture and fenestration; whereas columniation is mostly so employed as to appear something quite adscititious—a mere *hors d'œuvre*, and perhaps an inconvenient and encumbering one into the bargain.

Wilkins, who plumed himself so much upon his rigorous observance of classical proportions as to intercolumniation in the portico of the National Gallery, does not seem to have duly considered the consequences of it in regard to the interior of the portico. Had there been within only a single door of loftier proportions, recessed as at present between two columns in antis, there would have been nothing to contradict or disturb the close intercolumniation affected for it; whereas now the interior looks crowded-up even to confusion, and the end doors are of too wide and low proportions, so as to appear crammed into the spaces they occupy, although those spaces correspond to two intercolumns in front.

There is another species of combination of the two systems (columnar and fenestrated) which ought to be noticed, namely, that wherein columniation is employed only for one or more distinct portions of a façade, the rest of it being *astylar* and fenestrated. The Post Office exemplifies such combination the centre portion exhibiting columniation without windows, and the two next fenestration only; while the extreme compartments of the front display, both fenestration and columniation together; the latter however as mere embellishment, because though the columns are insulated, they do not form any sort of practicable colonnade or loggia, therefore seem still more idle and useless than such as by being attached to a wall appear in some degree to perform the office of buttresses to it. Well, what is the effect of the combination alluded to?—does it not partake rather too much of the *sandwich*, the composition being that produced by mere juxtaposition? We behold a portico of temple-like aspect clapped between what look like two distinct buildings, altogether different from it in character and style—constituting a sort of *macaronic* architecture—and by no means very satisfactory in themselves. Of the window dressings we need not speak, they being little more than architectural fig-leaves to screen positive nudity; but the fenestration itself is poor and undignified; the windows are too close together, neither is there sufficient space between the two tiers of them; whence there is nothing of that simplicity which arises from breadth and repose. Notwithstanding however the odd patching together of modern *poly-fenestration* with the windowless system of the Greeks, the Post Office was hailed at first by the Greekomania of the day, as something vastly classical; and so well satisfied with it is the architect himself, that he is now giving us a second edition of it in the façade of the British Museum.—Pity, he is so slow about it, for Greekomania will be all evaporated before that *chef-d'œuvre* of pure classical taste, "neat as imported," be completed.

In the two buildings erected as detached wings to the Museum façade, we have fenestration between a single order of pilasters, carried the height of three floors, which mode certainly preserves due width of spacing as regards the pilasters themselves, but it causes the windows to appear meagre and insignificant, and too much cramped up.

One Greek example of a design for windows there is, namely that afforded by the Triple Temple at Athens, which we could wish had never been made known to us, because then it is most likely that when they wanted windows for buildings in the Grecian Ionic style, architects would have derived ideas for the purpose, from the exquisitely beautiful doorway in the tetrastyle portico of the edifice just mentioned, whose highly finished and delicate ornateness correspond perfectly with that of the order; whereas the window does not partake of, or agree with the order at all; there being no more than a very plain border round the aperture, defined by an external moulding. Yet this unlucky precedent has been taken by us, in our Greekomania, as an authority to be implicitly adhered to on all occasions—no matter how different those occasions may be in themselves. Be the order Doric or Ionic, or if the latter, the plainest or the richest in character, we find that *universal* window perpetrated everywhere alike, as if no modern architect could muster up imagination enough to design a dressing for a window aperture just as easily as for that of a door or a fire-place. Thus instead of being made characteristic features in our modern Greek style, windows are suffered to become quite negative ones,—monotonous, feeble, and inexpressive.

In the Gothic or Pointed style, on the contrary, fenestration is so characteristic, as to be almost indispensable on that account alone; and is besides differently constituted, and accordingly subjected to other conditions,—most certainly is emancipated from most of those restraints and regulations which it has to submit to in Greco-Roman, and Italian architecture. But leaving our readers now to cogitate upon what thus far we have said, we reserve our remarks upon Gothic fenestration till we return to the subject next month,—

"che 'l Canto presente
Non è bastante a dirla degnamente."

—

PRACTICAL PROBLEMS IMPORTANT IN PLANE TRIGONOMETRICAL SURVEYING.

By Oliver Byrne, Professor of Mathematics.

Sir,—In the October Journal of last year, you published a portion of an article of mine, entitled "Problems on Plane Trigonometrical Surveying," as soon as convenient, I hope you will insert the remainder. That spirit of fairness, which has ever been an ascendant property of your valuable publication, will secure also, I feel confident, a corner for the succeeding remarks. The subjects upon which I have written, if they have no other recommendation, have at least the quality of being original; but, in the case of these problems, originality has been questioned by Mr. Turnbull, which, I believe, could not have been done, had the whole of my paper appeared. But, for the following editorial remark, appended to Mr. Turnbull's communication, I would have attended more promptly to the matter: —"We regret to say, that Mr. Turnbull's present letter appears to have been written under most painful circumstances; they are of too private a nature to be made public, but we can assure the reader that they entirely preclude any further strictures on Mr. Turnbull's past productions." Mr. Turnbull says, speaking of me, "The principle from which the Professor deduces the solution was first employed by me for that purpose in 1829, when all the cases of the problem were resolved exactly in the same manner as in your Journal." Why did he not state his principle and compare it with mine? He further adds, "The problems, with their solutions appeared in one of the earliest numbers of Colburn's United Service Journal, but, being without signature, the author's name was unknown to the public." Under the head "Stasimetric Surveying," Colburn's United Service Journal, second part, page 75, 1829, the first four or five problems given by me in your Journal, were solved from the following principle; "The angles of the figure can be ascertained in terms of those observed without involving any of the containing or subtending parts, and hence the distance between two remote objects become known in terms of the observed angles and the measured base. If to all the angles of any plane polygon figure, right lines be drawn from a point within it the product of the sines of the alternate angles will be equal to each other." From what Mr. Turnbull calls an obscure and neglected proposition in Emerson's Trigonometry, *the above principle was very readily drawn.* It will be found that the principles on which Emerson, Gregory, and the writer in Colburn's Journal, proceeded, are but particular cases of the very extensive one, upon which I have based my solutions; this will become very evident when the whole of my paper is published. You will find that I worded my general principle thus:—"If any number of lines A, B, C, D, &c., be drawn, the ratio propounded of the ratios of A : B, B : C, C : D, &c., continued in order to A, is a ratio of equality: or which is the same thing, when each becomes an antecedent and a consequent, taken in the above mentioned order, the continued product of the antecedents is equal to the continued product of the consequents." My application of this proposition I consider entirely original; I have used it in the solution of numerous problems, a few of which I have submitted to you for publication.

When the whole of them appear, I will revert to the subject again.

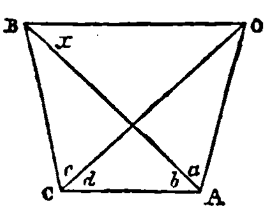
I am, Sir, your's sincerely,

OLIVER BYRNE.

Continued from Part XCVII., Oct., 1845.

(5.) In order to determine the horizontal distance between two remote objects, O, B, a base line A C, of 500 chains was measured, then at each extremity of this base the following angular distances were taken:—At A, OAB $= 75° 50' = a$, BAC $= 45° 05' = b$; at C, OCB $= 75° 30' = c$, and OCA $= 40° 20' = d$. Required the distance between the two objects? From having the angular distance a, b, c, d, all the other angles of the figure may be found, without knowing the lengths of any of the lines; therefore, from having the length of any of the lines, under such circumstances the remaining linear distances can easily be determined. Let angle OBA $= x$, ABC $= 180° - b - c - d = e$. Then OBC $= e + x$. $\therefore$ OA : OB $=$ sin. x : sin. a; OB : OC $=$ sin. c : sin. $(e+x)$; and OC : OA $=$ sin. $(a+b)$: sin. d. Hence, sin. $(a+b)$ sin. c sin. $x =$ sin. a sin. d sin. $(e+x)$; sin. $(a+b)$ sin. $c =$ sin. a sin. d $\frac{\sin.(e+x)}{\sin. x}$. But, $\frac{\sin.(e+x)}{\sin. x} = \frac{\sin. e \cos. x + \cos. e \sin. x}{\sin. x} = \sin. e \cot. x + \cos. e$. $\therefore$ sin. $(a+b)$ sin. $c =$ sin. a sin. d (sin. e cot. x + cos. e); sin. $(a+b)$ sin. c − sin. a sin. d cos. e = sin. a sin. d sin. e cot. x. $\therefore$ cot. $x = \frac{\sin.(a+b)\sin. c}{\sin. a \sin. d \sin. e} - \cot. e$; or, cot. x = cosec. a sin. $(a+b)$ sin. c cosec. d cosec. e − cot. e. RULE.—*Add together, the log. cosec. of a, the log. sin. of the sum of a and b, the log. sin. of c, the log. cosec. of d, and the log. cosec. of e; the natural number corresponding to this sum, rejecting 50 in the index, made less by the natural co-tangent of e, will give the natural co-tangent of x.*

Fig. 1.



a	$= 75°\ 50'$,	log. cosec.	$=$	10·0134127
$(a+b)$	$= 120\ 55$,	log. sin.	$=$	9·9334445
c	$= 75\ 30$,	log. sin.	$=$	9·9859416
d	$= 40\ 20$,	log. cosec.	$=$	10·1889391
e	$= 19\ 05$,	log. cosec.	$=$	10·4855379
				0·6072758
The natural number corresponding			$=$	4·0483290
The natural cot. of 19° 05′ (e)			$=$	2·8905467
Natural cot. of x			$=$	1·1577823

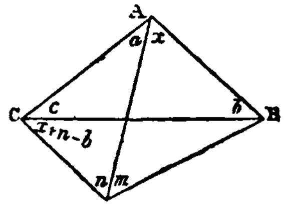
$\therefore x = 40° 49' 04'' =$ ABO; and $e + x = 59° 54' 04'' =$ OBC. Hence, OC $= 1334·49$, and OB $= 1498·34$ chains respectively, which may be found by Plane Trigonometry.

Suppose the angles a, b, c, d, remain as before, but it is found impossible to measure AC with any degree of accuracy, OB being on a plane it is measured and found to be 18609 links. Required the angle x, and the distance AC in feet? In this instance, $x = 40° 49' 04''$; and AC $=$ 4112·227 feet. This could not be solved by the rules of plane trigonometry.

(6.) There are four stations on the same plane, the linear distance between every two of any three of them being given, as well as the angular distance of the fourth from each of the other three; to find the remaining parts.

Let A, B, and C, be the three stations whose distances are known; hence the three angles a, b, and c, of the triangle ABC may be found. [See Problem III, in the Journal for October, 1845.] Having these three angles, and also m, and n, taken at the fourth station, we can find all the angles of the figure without any reference to the lengths of the lines.

Fig. 2.



Let x be the angle made by the diagonal AD and the side AB; then will the angle BCD $= b - n + x$. Hence, AB : BC $=$ sin. c : sin. a; BC : BD $=$ sin. $(m+n)$: sin. $(b-n) + x$; and BD : AB $=$ sin. x : sin. m.

$\therefore$ sin. c sin. $(m+n)$ sin. $x =$ sin. a sin. $\{(b-n)+x\}$ sin. m.

$\frac{\sin. c \sin.(m+n)}{\sin. a \sin. m} = \frac{\sin. \{(b-n)+x\}}{\sin. x} = \sin.(b-n)\cot. x + \cos.(b-n)$. $\therefore \frac{\sin. c \sin.(m+n)}{\sin. a \sin. m} - \cos.(b-n) = \sin.(b-n)\cot. x$. $\therefore$

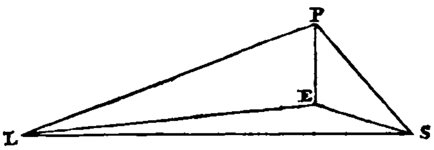
$\frac{\sin. c \sin.(m+n)}{\sin. a \sin. m \sin.(b-n)} - \cot.(b-n) = \cot. x$. $\therefore$ cot x = cosec. a sin. c cosec. m sin. $(m+n)$ cosec. $(b-n)$—cot. $(b-n)$. If $b = n$, the problem will be indeterminate, for cosec. $(b-n)$, or cosec. o, is infinite. It also shows that a circle can be described through the four points A, B, C, D; so that the point D, when such is the case, will have an infinite number of positions all satisfying the question. When A, B, C, are in the same right line, this problem is readily solved by problem 2. Or when any two of the stations A, B, C, and the station D, are in a straight line, the problem falls under the resolution of plane triangles. It may also be remarked, that the angles b and c, are negative when the point A is below the line BC. RULE.—*Add together the log. cosec. of a, the log. sine of c, the log. cosec. of m, the log. sine of (m+n), and the log. cosec. of (b—n); the natural number corresponding to this sum after a proper allowance is made in the index, made less by the natural cotangent of (b — n) will give the natural cotangent of x.*

This problem, of which the three following examples are particular cases, was first proposed by Richard Townley, in the *Philosophical Transactions*, where also is inserted solutions to the different cases by John Collins, No. 69, 1671. The first of these examples is given in the *Lady's Diary* for 1723, by John Richards, and answered the following year by John Topham. Dr. Hutton in his edition of the Diaries gives an additional solution, with a geometrical construction. Professor Leybourn, in his edition of the Diaries, gives a second additional solution, also with a geometrical construction; and in his appendix to the same work, he gives a general one from "Cagnoli's Trigonometry." However, none of these solutions are as simple or as practical as the one here given. Cagnoli makes cot. $x =$ cot. $(B - n) \left\{ \frac{\sin. c \sin.(m+n)}{\sin. BAC \sin. m \sin.(B-n)} - 1 \right\}$. It should be cot. $x =$ cot. $(B - n) \left\{ \frac{\sin. c \sin.(m+n)}{\sin. BAC \sin. m \cos.(B-n)} - 1 \right\}$

This must be a misprint, for it cannot be supposed that either Cagnoli or Leybourn could make such a mistake.

I. It is required to find the distance from the Edystone Lighthouse to Plymouth, Start Point, and the Lizard, respectively, from the following data:—The distance of Plymouth from the Lizard 60 miles, from Lizard to Start Point 70 miles, and from Start Point to Plymouth 20 miles; also Plymouth bears due north from the Edystone Rock, the Lizard W.S.W., and Start Point N. by E. Let E represent the position of the Edystone, L the Lizard, P Plymouth, and S Start Point. When a right line is sup-

Fig. 3.



posed to be drawn from L to S, it is evident that the point E falls within the triangle L P S, the angles of which are found by problem (3) to be as follows:—

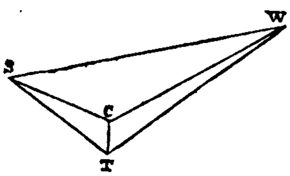
$\angle$SPL = 112° 01′ 27″ = a;
$\angle$PLS = 15 21 32 = b;
$\angle$PSL = 52 37 01 = c; we have also
$\angle$PES = 112 30 00 = m = 10 points, or W.S.W.
$\angle$PEL = 78 45 00 = n = 7 points, or N. by E., and
$\angle$LPE = x. Then by the general rule we have,

log. cosec. a = 10·0329082
log. sin. c = 9·9001454
log. cosec. m = 10·0313847
log. sin. $(m+n)$ = 9·2992357
log. cosec. $(b-n)$ = 10.0486213

Reject 50 and 49·3062953 = $\bar{1}$·3062953 = log. of 0·2024395; from which substract — ·5002568, the natural cotangent of $(b-n)$, and we have, 0·7032063 for the natural cot. of x, ∴ x = 54° 52′ 40″ = L P E. The distances L E, S E, C E, can be found by Plane Trigonometry, and are 53·11906; 17·1334; and 13·91746 miles respectively. John Topham makes them 53·04; 17·36; and 14·333 respectively.

II. Being at a town in Kent I observed three objects on the other side of the river Medway, a castle (C), a windmill (W), and a spire (S), whose distances from one another are known; from the castle, (the nearest object seen,) to the spire, (C S) is 10 furlongs; from the castle to the windmill (W C), 23 furlongs; and from the windmill to the spire (W S), 25 furlongs.

Fig. 4.



I took with a theodolite, the angular distance between the castle and the spire (C T S) and found it to be 28° 34′, and between the castle and the windmill (C T W) 57° 45′; what distance did I stand from each of these objects? From having the three sides of C S W we can find the three angles by problem 3; hence we have,

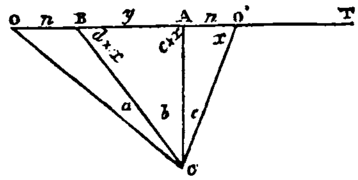
a = 89° 30′ 06
b = 23 34 38
c = 66 55 16 } Being calculated independant of each other, and making 180° affords a proof.
m = 57 45 00
n = 28 34 00

∴ $(m+n)$ = 86 19 00; and instead of $(b-n)$ take $(b+n)$ = 52 08 38 negative. Putting x = $\angle$T C W; and proceeding according to the general rule, we find the sum of the five logarithmic quantities to be 50·1382785, or 0·1382785 which correspond to the natural number 1·374923, which is negative. From — 1·3749236 take the the nat. cot. (52° 08′ 38″) = 0·7773423 and it leaves — 0·5976737:—this nat. cot. corresponds to 59° 08′ 04″; ∴ x = 120° 51′ 56″. Then (59° 08′ 04″) — (57° 45′ 00″) = 1° 23′ 04″ = $\angle$T W C. To find the remaining parts fall under the head of common-place Trigonometrical calculations. T W = 23·3439 furlongs, T C = 9·6570643, and C S = 10·57215.

III. In a garrison there are three remarkable objects, A, B, C, the distance of which from one another are known to be as follows:—B A = 213, B C = 424, and A C = 262 yards. I am desirous of knowing my position and distance when standing at a station A, with respect to the three points A, B, C; at A T observed A to be the nearest object, and the angles B S A = 13° 30′, A S C = 29° 50′. This example was originally proposed in Dr. Hutton's Conic Sections, then reproposed in the Lady's Diary for 1797, where two different solutions are given the following year; but none of the different solutions to any of the cases of this problem are as practical as following the general rule here given. A S will be found = 429·6814; C S = 524·2365; and B S = 605·7122 yards.

(7.) In running a mean line through a country, I arrived at the bank of a river, B; and having booked a station at O, I find by subtraction that O B is 25·36 chains: causing a flagstaff to be plased at O, and another at B, I crossed the river in a boat, and set up a third at A, in a right line with B and O. Proceeding along the line to O′, a distance of 25·36 chains, a fourth flagstaff is set up; then continuing the line to a convenient point T, a theodolite is set up and the point in each staff as O, B, A, O′,

Fig. 5.



which is cut by the same borizontal plane is noted. Now at C any station where the points O, B, A, O′, can be seen, I take the angles a, b, c, and find them to be 12° 05′, 28° 25′, and 17° 23′ respectively; required the breadth of the river A B? Let B A = y; the angle A O′ C = x, then will $\angle$B A C = $c+x$, and A B C = 180° — $b-c-x=d-x$; also d = 180° − $b-c$ = 134° 12′: B O C = 180° − $a-b-c-x$, putting e = 180° − $a-b-c$ = 122° 07′. In this problem we shall compare the ratios round two points O and O′.

First round O, O B : O A = $n : n+y$;
O A : O C = sin. $(a+b)$: sin. $(c+x)$;
O C : O B = sin. $(d-x)$: sin. a.
Second round O′, O′ A · · O′ B = $n : n+y$;
O′ B : O′ C = sin. $(b+c)$: sin. $(d-x)$;
O′ C : O′ A = sin. $(c+x)$: sin. c.

We obtain directly from compounding both the analogies and expunging the common factors,

$$\frac{\sin.(d-x)}{\sin.(c+x)} = \sqrt{\frac{\sin. a \sin.(b+c)}{\sin. c \sin.(b+a)}}.$$

Let the right hand member of this equation for the sake of brevity be called K. But, sin. $(d-x)$ = sin. $(180°-b-c-x)$ = sin. $(b+c+x)$. ∴ $\frac{\sin. \{b+(c+x)\}}{\sin.(c+x)}$ = K.

∴ sin. b cot. $(c+x)$ + cos. b = K.

$$\therefore \cot.(c+x) = \frac{K}{\sin. b} - \cot. b.$$

$$\therefore x = \cot.^{-1}\left\{\left(\frac{\sin. a \sin.(b+c)}{\sin. c \sin.(b+a) \sin.^2 b}\right)^{\frac{1}{2}} - \cot. b\right\} - c.$$

From this equation the rule is deduced. We need scarcely remark, that before finding any of the distances is necessary to find the unknown angle x.

Rule.—*Add into one sum the log. sin. of a, and the log. sin. of $(b+c)$; then add together the log. sin. of c, the log. sin. of $(b+a)$, and twice the log. sin. of b: subtract the latter sum from the former and divide the remainder by 2, the neutral number corresponding to the quotient made less by the nat. cot. of b, will give the nat. cot. of $(c+x)$, and consequently x becomes known.*

Log. sin. 12° 05′ (a) = 9·3208460
log. sin. 45 48 $(b+c)$ = 9·8554654

Reject 20 19·1763050
From $\bar{1}$·1763050
Take $\bar{2}$·6428665

Log. sin. 17° 23′ (c) = 9·4753271
log. sin. 40 30 $(a+b)$ = 9·8125444
2 log. sin. 28 25 (b) = 19·3549950

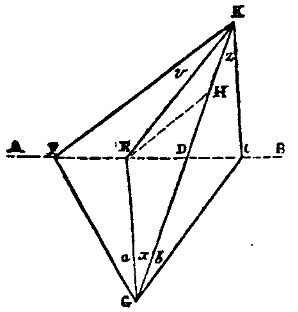
Reject 40 38·6428665
$\bar{2}$·6428665

This divided by 2)0·5334385 = 0·2667192 which correspond to the nat. number 1·8480730, this is to be made less by the nat. cot. of 28° 25′ (b) = 1·8481761, which is greater than 1.8480730 by 0·0001031; ∴ this is the negative nat. cot., and corresponds to 21″; hence, $(c+x)$ = 90° 0′ 21″; but c = 17° 23′, ∴ x = 92° 37′ 21″. The remainder of the calculations are common place. B A = 43·88967; A C = 81·009 chains. Before proposing the next problem, which is rather complicated, we wish to remark, that it is given more to illustrate the properties of the foregoing analogies than for any practical utility.

(8.) In superintending an extensive survey, I gave directions to an assistant who chained one of the base lines, A B, to set up flagstaffs equally distant from each other as he passed over a common which lay in his way; not knowing the comparative length of his proposed line, he was not confined to any particular distances. Now it so happens, that he sets up a staff at each of the four points C, D, E, F, as in the annexed sketch, and continued the measurement of the line. A second assistant who measured a tie line from G to K, before leaving G, took the angular distance between E and F at 16° 16′ 16″; this was the only angle he could take from the point G, he not being able to see C or D, though from the direction C lay, he knew the angle F G C, to be acute:—then measuring from G to K, his line exactly passes through the station D; but when I met him at H, the chain he was using was not correct. Therefore, the only particular we knew of this line was, that G D happened to be the same number of false chains as D H. Leaving this assistant to take the angle E H D, which he makes 34° 34′ 34″, I measured H K, with a correct chain and found it to be 1500 links, and at the station K, I took the angle F K C at 70° 10′ 10″; not being able to see D or E. It is required from this data to find the length of the different lines; not having any information from the first assistant as to the distance he placed the pickets, and on returning to remeasure the distances, the exact place where they stood could not be ascertained.

Now, we have given, the distance CD = DE = EF; and DG = DH; also HK = 1500 links. Likewise, ∠FGE = 16° 16′ 10″ (a); EHD = DGC = 34° 34′ 34″ (b); and FKC = 70° 10′ 10″ (c). Let ∠ DGE = x, DEG = y, CKG = z, and EKF = v. ∴ CDG = $(x+y)$, FKD = $(c-z)$, and EKG = $(c-v)$. Hence, by comparing the ratios round two points C, and E, we have

Fig. 6.



CD : CE = 1 : 2;
CE : CG = sin. $(b+x)$: sin. y;
CG : CD = sin. $(x+y)$: sin. b;
FE : FD = 1 : 2;
FD : FG = sin. $(a+x)$: sin. $(x+y)$;
FG : FE = sin. y : sin. a. By compounding these six ratios and expunging the common factors we have, sin. $(a+x)$ sin. $(b+x)$ = 4 sin. a sin. b. cos. $(b-a)$ — cos. $\{(a+b)+2x\}$ = 2 sin. $(a+x)$ sin. $(b+x)$ = 8 sin. a sin. b. Cos. $(a-b)$ — 8 sin. a sin. b = cos. $\{(a+b)+2x\}$. But, — 8 sin a sin. b = 4 cos. $(a-b)$ + 4 cos. $(a+b)$; ∴ 4 cos. $(a+b)$ 3 cos. $(a-b)$ = cos. $\{(a+b)+2x\}$. An arc whose cos. is 4 cos. $(a+b)$ = 3 cos. $(a-b)$, written thus:—Cos.$^{-1}$ 4 cos. $(a+b)$ = 3 cos. $(a-b)$; made less by $(a+b) = 2x$. ∴ $2x$ = cos.$^{-1}$ $\{4 \cos.(a+b) - 3 \cos.(a-b)\} - a - b$.

Whence the Rule.—*From four times the natural cosine of $(a+b)$, take three times the natural cosine of $(b-a)$; an arc whose natural cosine is the remainder, made less by $(a+b)$, and divided by 2, will give x.*

$(a+b)$ = 50° 50′ 50″, 4 nat. cos. = 2·5255616 } subtract.
$(b-a)$ = 18° 18′ 18″, 3 nat. cos. = 2·8481943 }

Difference = 0·3226327 negative.

The angle which corresponds to this nat. cos. in the table is 71° 10′ 41″; but as the cos. is negative, the angle may be 108° 49′ 19″, or 251° 10′ 41″; but it cannot be the latter, because the angle FGC is known to be acute.

Then from 108° 49′ 19″
take 50 50 50 = $(a+b)$

half of 57 58 29 = 28° 59′ 14″·5 = x = KGE.

In order to determine y, let us compound the ratios of the lines drawn from E, which are compared in the foregoing ratios. Hence we have sin. $(a+x)$ sin. y = 2 sin. $(x+y)$ sin. a. But, sin. a cos. x sin. y + cos. a sin. x sin. y = 2 sin. x cos. y sin. a + 2 cos. x sin. y sin. a. This divided by sin. y, gives sin. a cos. x + cos. a sin. x = 2 sin. x cot. y sin. a + 2 cos. x sin. a. ∴ sin. a cos. x + cos. a sin. x — cos. x sin. a = 2 sin. x sin. a cot y; sin. x cos. a — cos. x sin. a = 2 sin. x sin. a cot. y. ∴ $\frac{\sin.(x-a)}{2 \sin. a \sin. x}$ = cot. y. From this value of cot. y, the following method of calculating y is deduced: Rule.—*Add together the log. sine of $(x-a)$, the sub. log. of 2, the log. cosecant of x, and the log. cosecant of a; the sum will be the log. cotangent of y.* By this rule y is easily found, and x is known,—call their sum m. [Which will be found too by 79° 57 35″·5]. Then to find z, we have

FD : FC = 2 : 3;
FC : FK = sin. c sin. $(m-z)$;
and FK : FD = sin. m sin. $(c-z)$;
∴ 2 sin. c sin m = 3 sin. $(m-z)$ sin. $(c-z$;
cos. $(m-c)$ — cos. $\{(m+c)-2z\}$ = 2 sin. $(m+z)$ sin. $(c-z)$.
= $\frac{4}{3}$ sin. c sin. m;
cos. $(m-c)$ — $\frac{4}{3}$ sin. c sin. m = cos. $\{(m-c)-2z\}$.
But, cos. $(m-c)$ — cos. $(m+c)$ = 2 sin. c sin. m
∴ $\frac{2}{3}$ cos. $(m-c)$ — $\frac{2}{3}$ cos. $(m+c)$ = $\frac{4}{3}$ sin. c sin. m
$\frac{1}{3}$ cos. $(m-c)$ + $\frac{2}{3}$ cos. $(m+c)$ = cos. $\{(m+c)-2z\}$.
∴ $2z = (m+c) - \cos.^{-1} \frac{1}{3}\{\cos.(m-c) + 2\cos.(m+c)\}$.

Rule.—*Add together the natural cosine of $(m-c)$ and twice the natural cosine of $(m+c)$, and divide the sum by 3; the result will be the natural cosine of an angle, which angle taken from $(m+c)$ will leave twice z.*

This gives the angle = 22° 50′ 14″ = v = CKG. To find the angle GKE = v, we have FKG = $(c-z)$ = 47° 19′ 56″ = n; FDK = $(x-y)$ = 79° 57′ 35″·5 = m.

We have also, FE : FD = 1 : 2;
FD : FK = sin. n : sin. m;
and FK : FE = sin. $(m+v)$: sin. $(n-v)$.
∴ sin. n sin. $(m+v)$ = 2 sin. m sin. $(n-v)$;

sin. n (sin. m cos. v + cos. m sin. v) = 2 sin. m (sin. n cos. v — cos. n (sin. v). Sin. n sin. m cos. v + sin. n cos. m sin. v) = 2 sin. m sin. n cos. v — 2 sin. m cos. n sin. v. Dividing by sin. n sin. m sin. v, we have, cot. v + cot. m = 2 cot. v — 2 cot. n;

∴ cot. m + 2 cot. n = cot. v: which affords the Rule.—*To the natural cotangent of m, add twice the natural cotangent of n; the sum will be the natural cotangent of v.* ∴ v = 26° 19′ 55.″ All the other angles of the figure can be found by addition and subtraction; and any of the linear distances calculated at pleasure. EH, ED, and GK, will be 46·4013, 26·7423, and 100·7355 chains, respectively.

THE PRACTICE OF SETTING OUT RAILWAYS AS PRELIMINARY TO THE CONTRACT WORKS.

The duty of an engineer when setting out a line of railway, finally and permanently, has not, so far as I am aware, been described in any publication. It may be serviceable to some of the readers of the Journal to show in what it consists, and to impress the evident fact that its careful and accurate performance is important in every department of the construction of the line, and to the interest of the railway company in relation to the landowners. Can anything be more discreditable than a distorted or irregular alignement;—than a deviation from the gradients established on the permanent section, or than winding slopes? Can anything be more injurious to the character for honesty, which a railway company, through its servants, ought to maintain, than the frequent squabbles with landowners as to the quantity of land purchased from them? Discreditable, however, as these exceptions to propriety are, instances of them all are familiar to the practical engineer. They are in many cases attributed perhaps to the hurry of commencing the contract works, most frequently they can be traced to the want of experience or of care on the part of those entrusted with the duty of permanently setting out the line.

To assist the inexperienced and to direct attention to the points which chiefly require care, is my purpose in offering a contribution to the pages of the Civil Engineer and Architect's Journal, upon this part of an engineer's practice, and it has been my object to avoid all, but the simplest forms of calculation, to reduce them to the fewest in number, and to show how they may be made with the least trouble—in fact, so as to save all the trouble that it is possible, consistently with accuracy.

A line of railway is permanently set out,—First, by tracing upon the ground the *centre line*, which must conform to the final plan, as to curves and tangents.

Secondly, by planting permanent bench marks to indicate the gradients laid down on the final section.

Thirdly, by marking off the widths so as to show the space occupied by the railway at formation level, or balance line, by the slopes, and by fence and ditch, from the dimensions presented by the cross sections.

To the two last operations it is proposed to confine this paper.

Setting out Gradients.

A fixed point to which the gradients are referred is always determined at one end, at least, of a proposed line of railway, and from this point the levels must be carried forward, following the centre line, which, it is assumed, has already been marked by pegs or stumps at distances which ought not to exceed four or five chains. Two levelling staves, a chain of fifty feet in length, and a perfect spirit level in complete and accurate adjustment, are the instruments with which the engineer should be equipped, and which he will require to use with skill and expedition.

The gradients should be laid down in the field,—

1st,—By measuring the length of each from end to end, and fixing ordinary pegs to mark the beginning and termination.

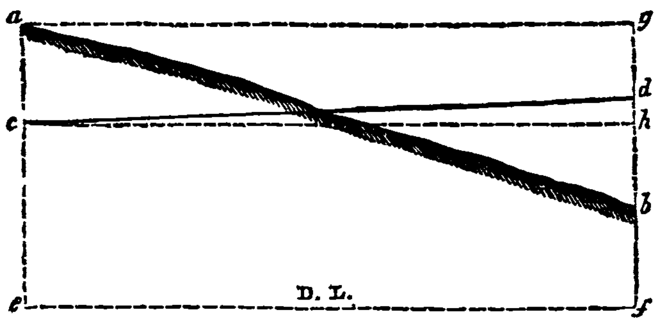
2nd,—By carrying a series of levels over the whole length of the gradient without using the chain, so as to determine the difference of level of the ground surface at each end of the gradient.

3rd,—By planting permanent bench marks within a convenient distance of the line, but secure from being buried or destroyed during the progress of the works.

These bench marks should be formed of posts of squared timber, 6 inches × 6 inches, secured round the head with an iron hoop, and either driven into the ground as a pile, or, being squared at the foot, set upon a slate, tile, or flat stone, in a hole dug to the depth of three feet, or thereabouts; and they should stand 2′ 6″ out of the ground. Upon this post a saw kerf, nick, or other mark, to be described in the level book, must be made as a reference to the height of embankment or depth of cutting at the end of the gradient, already marked by a peg on the centre line.

It is a matter of most essential convenience during the whole progress of the construction of a railway, that these bench marks should be readily accessible and properly protected from injury or derangement, and a little expense incurred to attain this end will save ultimate cost, in the shape of time, to all parties interested, whether contractor or engineer.

Fig. 1.



The only calculation requisite to complete this preliminary operation is readily understood from the figure, in which $a\,b$ is the ground surface, $c\,d$ the gradient line, and $g\,b$ the difference of level at the surface between the limits of the gradient $c\,d$. Then, as we know the position of the point c, with reference to a, at the beginning of the gradient, that is, in the present figure, the depth of cutting $a\,c = g\,h$, then $g\,b - g\,h + h\,d = b\,d$ the height of embankment at b.

Now, to render this process perfectly general and free from any hesitation in applying its result, the following conventionality must be borne in constant remembrance:—

Calling, B the sum of all the back sights.
F the sum of all the fore sights.
G the rate of inclination of the gradient or the height $d\,h$, through which it rises or falls in its whole length.
C the depth of cutting or height of embankment at one end.
C′ the same depth or height at the other end.

Then the general formula is $B - F + C - G = C'$.

In which we must use the positive or negative sign to C and G, as the circumstances may be, thus—

When C is in *cutting* it is always taken with the positive sign; when in *embankment*, with the negative sign.

When G is a falling gradient, it is to be prefixed by the negative sign; when a rising gradient, by the positive sign.

Then the sign which will be the result attached to C′ will indicate whether the end of the gradient is in cutting or embankment.

Suppose a case, in which $B = 200$; $F = 208$; $C = +6$; and $G = +3$; then, $200 - 208 + 6 - 3 = -5$, where we have a cutting of 6 feet at the beginning of the gradient, and an embankment of 5 feet at the other.

Suppose we use the same figures, but work the reverse way; then $208 - 200 - 5 + 3 = +6$.

A little consideration will make this familiar, and the remembrance of the proper signs will be facilitated by connecting them with the fact, that when the ground *falls*, the difference of level is *negative*; or, in other words, the sum of the fore sights is greater than the sum of the back sights. In the same way, when a gradient line *falls*, the expression G is negative. On the other hand, where the ground *rises*, the difference of level is *positive*, for the sum of the back sights will exceed the sum of the foresights; and in like manner, when a gradient line *rises*, the expression G is positive. Also a *negative* sign before C shows that the ground surface is below the gradient line; and when the sign is *positive*, that the ground surface is above the gradient line; the first indicating an embankment, the last a cutting.

The inclination of the gradient must, on no account be taken from the ratio of inclination usually given on the section, but the difference of the heights above datum at the ends of the gradient must alone be employed in all cases.

The ground between the ends of each gradient must be levelled over at least *twice*, and should any difference appear, it must be gone over until all uncertainty as to the truth of the result vanishes; and *then*—and *not until then*—the height of embankment or depth of cutting, above the nick, or saw-kerf, in the bench mark, should be properly painted in figures on the post, say in red paint for cuttings, and in black or white for embankments.

When the length of the gradient is, in the first instance, chained out, pegs should be driven into the ground occasionally where the rise or fall amounts to a whole number; thus suppose a gradient of 1 in 300, a peg at 300 would show that the rise was 1 foot; at 900 feet that it was 3 feet; and so on. The use of these pegs is to serve as a check upon the levels taken for the widths, where an accumulation of small fractional parts of a foot, individually too small for reading on the staff, and therefore neglected in each chain's length, might amount to a serious multiplied error if carried on; and for distinction these pegs should be painted red.

Marking off the Widths.

The first step, at this stage of the work, is to divide the entire length of each gradient into spaces of one chain, or 50 feet each; for these spaces, levels to determine the height of embankment or depth of cutting should be simultaneously carried on with the chaining and measurement of the widths. It is not uncommon that the surface of the ground is covered with soil or grass turf, which is directed in the specification of earthwork to be removed from the site of each embankment, and set aside and reserved from each cutting before the embankments are begun, and to be used subsequently in soiling the slopes, in forming mounds for the quick fences, or to be disposed of to farmers or others. In calculating, therefore, the quantities of earthwork in each chain's length (for it is presumed the contract quantities will be computed from the level books, and not according to the lazy method of scaling heights from a section), we must bear in mind that the removal of this soil increases the quantity in every embankment, and decreases the disposable number of cubic yards in every cutting; and the thickness of soil directed to be removed must be added to the heights of embankment shown, as taken from the surface, in the level books; and must in the same way be subtracted from the depth of cuttings. For the widths, however, the existing surface must be worked from.

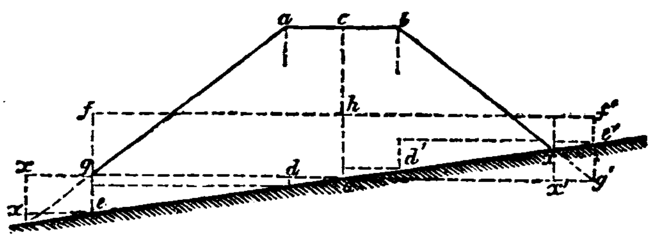
We will now suppose then, that commencing at the beginning of a gradient, a length of 50 feet has been measured along the centre line, the spirit level set up, and a back sight to commencement, as well as a foresight to the end, of the chain's length observed and entered on a level-book, the form of which will be presently given.

The height of embankment, or depth of cutting, must be then calculated, as already explained, for the value of C′, and also entered on the level-books. Half the width of the roadway must be measured off horizontally on each side of the centre line, and at right angles to it, and also a space for each slope corresponding to the value of C′, multiplied by the ratio of the slopes. A reading from the level staff, taken at each of these last points, and entered on the level-book, completes the first part of the field work.

The values of G, or inclination of the gradient, for the several distances of 50 feet, should be very accurately calculated, and entered in the proper column of the level-book in the office;—and it is not sufficient that this calculation be made for one distance and repeated; but the sum of the inclinations for any number of separate lengths should correspond with the inclination for the whole length; so as to correct any multiplication of minute errors from the necessary omission of small decimals.—For example: On a gradient of 1 in 300, the value of G for 50 feet would be 0·16666, &c.; now, if we used 0·17 as the nearest approximation and repeated it, we should obtain a total difference of 17 feet in one hundred lengths of 50 feet; whereas the correct difference for 5000 feet is 16 feet 8 inches. But if we take G, for the first two lengths as 0·17, and for the third 0·16, and pursue the same alternation for the entire length, we shall have a correct result. This will, it is hoped, be sufficient to show one subject deserving of care. All the points laid out should be marked by a nick in the ground; but if such a mark is not very visible, small wooden pegs must be employed.

The cross sections annexed exhibit what has been done so far, and what there still remains to do.

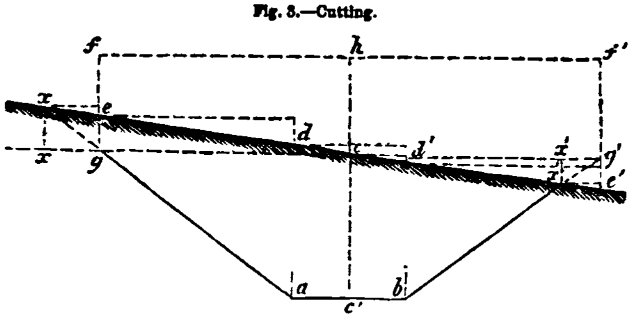
Fig. 2.—Embankment.



There has been determined, the height of embankment or depth of cutting cc'; the width, measured horizontally, of roadway cd, cd', and for slopes de, $d'e'$; and the heights ch, fe, $f'e'$ have been taken. And there remains to calculate, the horizontal addition to the widths for slopes ex on one side, and horizontal deductions on the other side, $e'x'$. The properties of the similar triangles cge, cxx, and of xxg, agd, afford a variety of expressions for the distance xg; and in making a selection from them, I have chosen that which requires the least quantity of field work, without increasing the labour in the office.

The notation employed will be—

Fig. 3.—Cutting.



C′, to represent the height of embankment, or depth of cutting.

r = the ratio of the slopes.

B = half the width of roadway, ac, or cd.

h = the height read off the staff at the centre, ch.

h' = the height read off at the edges of the slopes as first set out, that is fe and $f'e'$.

Take $H = h - h'$. The expression then for the horizontal distance gx in its general form is $\dfrac{(rC' + B)H}{C' + \dfrac{B}{r} - H}$.

In applying this formula we must pay attention to the essential signs of H and $\frac{1}{r}$, as well as of C′.

As already explained, the essential sign of H is *positive* when the ground in cross section is rising, and is *negative* when it is *falling*; and the sign of $\frac{1}{r}$ is to be taken as *negative* in EMBANKMENTS, for the slopes *fall* from the centre towards either side,—and as *positive* in CUTTINGS, because the slopes *rise* in the same manner; the sign by which the result is affected will show whether it is to be added to, or deducted from the width already set out for slopes.

The calculation of this formula is best performed in the office; and the result in each case should be entered in the proper columns of the level-book, to be set out on the ground on the next day devoted to field work, when the marks indicating the spaces for slopes should be removed, and replaced after the corrections.

It is recommended to use the ordinary slide rule in making the calculations—a modification, in the shape of two concentric circles of card board, divided on the edge into a logarithmic scale, of which the circumference of the smaller circle is the logarithm of 10, I have employed with much satisfaction. The outer circle is laid down on a rectangular piece of card-board, and divided from right to left; the inner circle is a separate card, cut exactly round its circumference, is divided from left to right, and is moveable upon the rectangular card on its centre; and all the calculations, involving multiplication and division, are performed by inspection. The smaller circle may conveniently be 3¼ or 3½ inches in diameter.

I need not encumber the Journal with a demonstration of the simple formulæ I have given; the investigation may, however, prove an amusement to the younger members of the Profession, and to them it will be a useful employment for half-an-hour. The only postulate is that the three points, c, e, x, should be in one straight line lying in the plane of the cross sections.

When the corrections to the widths for slopes are made which are due to the inclination of the ground surface, we complete the work by adding the necessary width for hedge and ditch, which should be measured off horizontally; this offers no difficulty.

When all the widths are measured off, the several lines are marked on the ground by nicking it with a spade or grafting tool, or by running a light furrow with a plough over the several marks.

A convenient form of level book for entering the particulars, which ought to remain on record, belonging to the setting out of the widths, has been alluded to in a previous part of this paper. I annex a form of this kind, and have inserted in it, the registry of a short length of railway, sufficient to offer a praxis, to those disposed to pursue the subject.

Form of Level Book to be used for Setting out Widths.

No.	Distance.	Gradient	Centre Levels.		Value of C′		Ratio of Slope	Horizontal Widths.			Cross Levels.		Difference of level from centre H.		Corrections for Slopes. Left.		Corrections for Slopes. Right.		Remarks.
	Feet.	G	Back. B	Fore F	Cutting.	Embankment.	r	Slope rC'.	R way. B	$\frac{B}{r}$	Left.	Right.	Rise.	Fall.	Add.	Subtract	Add.	Subtract	
0	0	0		4·12	10·5		1·5	15·75	15	10	2·22		1·9		3·15				Gradient rises
												6·32		2·2				2·96	2·4 ft. in 320 ft.,
1	50	0·37	4·12	7·95	6·3			9·45		10	4·95		3·0		5·5				or 1 in 133.
												9·85		1·9				2·53	
2	50	0·38	7·95	5·97	8·6			12·9		10	5·27		0	0	0	0			
												7·97		2·7				3·53	
3	50	0·37	5·27	11·50	2·00			3·0		10	13·4			1·9		2·45			
												10·2	1·3				2·25		
4	50	0·38	5·5	10·12		3	2	6·0	15	7·5	10·12		0	0	0	0			
												12·42		2·3			3·77		
5	50	0·37	4·88	9·71		8·2		16·4		7·5	6·91		2·8			4·75			
												11·41		1·7			3·81		
6	50	0·38	9·71	11·23		10·1		20·2			8·53		2·7			6·38			
												13·93		2·7			4·67		
7	20	0·15	11·23	12·98		12·0		24·0			9·73		3·2			5·5			
												14·58		1·6			3·4		
Total	320	2·4	58·66	68·76	10·5	12·0													

1, *Lancaster Place, August* 1, 1846.

J. H.

WESTMINSTER BRIDGE.

Report of the Select Committee appointed to consider the present state of Westminster Bridge, dated August 5, 1846.

The Committee having taken evidence on the subject of the present state of Westminster Bridge, unanimously agreed to the following resolutions and Report:—

Resolutions. I. That the majority of the witnesses who have been examined on the point concur in the statement, that the foundations of Westminster Bridge having been originally vicious, the bridge can never be permanently sound.

II. That the expense of completing the alterations and repairs new in progress or contemplation, according to contracts and designs under the superintendence of the bridge commissioners, will be very considerable, amounting at the least to £70,000.

III. That this expenditure will still leave the bridge in a state requiring constant attention in respect to repairs, and without any certainty of permanent security; while it will likewise leave the water-way far less adequate to the requirement of the navigation, particularly when the contraction of the stream by the embankment in front of the New Palace is considered, than would be the case under a new bridge.

IV. That, irrespective of the approaches, the expense of a new stone bridge near the site of the present bridge, and retaining the present bridge for temporary use, would not exceed £360,000, according to the highest of the estimates for that object which have been furnished to the committee, either in 1844, or in the present year.

V. That the bridge estates would probably furnish a clear surplus of at least £100,000, in aid of the funds for the erection of a new bridge.

VI. That Parliament having by direct grants from the Exchequer (the remaining expenditure having been provided by money raised in lotteries under Acts of Parliament) furnished a large part of the expense of erecting originally the present bridge, and having constituted the commission under which the said bridge was erected and has since been administered; and having by sec. 20 of the 9 Geo. II. c. 29, declared, that the said bridge shall be extra-parochial, and by sec. 21, that it shall not be a county bridge, maintainable as such bridges are by county rates, has recognized and sanctioned the principle that this bridge, which is thus by law excluded from other support shall be maintained, and when needful, repaired, restored, and rebuilt, at the expense of the State.

VII. That, in these circumstances, a sufficient case has been made out to justify this committee in recommending to the House, that the present bridge be pulled down, and that a new bridge be constructed; and that a bill be brought into Parliament next session to transfer to the Commissioners of Her Majesty's Woods, &c., the estates and property of the bridge commissioners, due consideration being had to the claims of the officers of the bridge estates, if their services should be discontinued.

Report.—The practical question which the committee had to decide, in relation to Westminster bridge, was, whether, under all the circumstances of the case, it were or were not desirable to endeavour to maintain the existing fabric of the bridge, or, on the other hand, to pull it down at once, and to substitute an entirely new bridge.

The result of the inquiry instituted in the session of 1844, and referred to this committee, proved unquestionably, that, without reference to money (*i. e.* assuming that the pecuniary means were forthcoming), every consideration of the convenience of the passage under and over the bridge, and even of economy when the expense of the maintenance of the existing structure is regarded, combined to recommend the removal of the old bridge, and the erection of a new bridge.

It was stated in substance by several witnesses examined in that year, that the foundations of Westminster bridge were originally defective; and therefore that the superstructure could never be made as effectively secure as if the whole were now rebuilt on an improved plan.

Even irrespective of the particular vice of the foundations, the character of the soil on which the bridge is built was sufficiently illustrated by the late Mr. Telford, in the following passage describing one of his own operations on the site: "I then proceeded to ascertain the nature of the matter of which the bed is composed, and on which the piers rest; and I found that an iron rod was easily pressed by hand through sand and gravel, to the depth of six and a half feet below the surface of the bottom of the river, or three and a half feet below the bottom of the platform; how much lower a longer rod might have penetrated I had not an opportunity of trying." And as to the foundations, James Walker, Esq., C.E., who was at the time, and still is, the professional adviser of the bridge commissioners, stated in 1844, "All the defects of the bridge have arisen from the imperfect foundation of the piers." In his original report to the commissioners of Westminster bridge, seven years before, namely, 28th February, 1837, Mr. Walker, after having stated "that for every useful and ornamental purpose a new bridge would be preferable, if the funds will justify the expense," proceeded to state the facts and reasons which led to such conclusion; namely, "that the piers of Westminster bridge were built in caissons, without bearing piles under them; that the bed of the river, for a considerable depth under the caissons, is loose gravel; and that the effect of the removal of the piers and dams of London Bridge is to increase the velocity of the ebbing current, and to deepen the channel between the piers, and thus to endanger the foundations." After the experience of nine more years, Mr. Walker, reviewing the whole case, and being requested to state his opinion as to the perfect stability of the existing fabric of the bridge" says, on the 19th of May, 1846, "After that bridge has sunk and twisted about in the way it has done, from the commencement of its building to the present time, I have seen enough of it not to risk anything like a professional opinion upon it," *i. e.* its perfect stability..... "I feel with reference to Westminster bridge, that it is like a patient whose constitution I did not make, which has been in the hands of doctors from the day it was built to the present time." Mr. Walker added, indeed, on the same day, "I do not think that there is any reasonable expectation of anything like a sudden failure of the bridge that would cause public danger; but when it is considered what an immense stake there is, in the case of any accident happening to the bridge, to be set against the taking of the thing boldly in hand, and making a complete job of it at once, to use an expression common with us, I must say, as I have said from the beginning, that it is nothing but a deference to the Lords of the Treasury which would in my mind make it politic at all to expend a great deal of money upon the repair of the old bridge." Mr. W. Cubitt, C.E., stated in 1837, in his report, "It also appears from the history of this bridge, that the foundations, as at present existing, were designed and calculated for much smaller piers, with a light wooden superstructure for a bridge; which plan was afterwards changed to that for the present stone bridge, and carried into effect upon the original foundations, by casing or lining out the piers, and surmounting them with heavy stone arches." Under these circumstances, it is not surprising, as was stated in a contemporary work, which describes the erection of the bridge,—that, "before the bridge was even finished, viz. in 1747, the third pier from the centre, viz. the fifth from the Westminster shore, began to sink; so that the two arches which rested on it departed from their circular figure, and some of their principal stones fell into the water." (*Gephyralogia*, 1751, p. 111). The remedy applied, in the first instance, according to that authority, was, to lay such a weight on the pier as to sink it gradually to the level where it might find rest. Accordingly, a weight "amounting to 12,000 tons" was laid on the sinking pier, apparently to sink it lower; and it "continued sinking several months after the weight was laid on." Three whole years was the use of this noble structure retarded by this accident," pp. 111-113. It is true, however, as the late Mr. Telford observed, in a memorable report which he addressed to the commissioners of Westminster bridge, on the 12th May, 1823, that "the dangerous instability of the piers of Westminster bridge seems to have passed into oblivion." It is true, also, as Mr. James Walker observed in his evidence, that, "in the course of 90 years the fabric had come to a state of repose, comparatively, until old London bridge was removed, the effect of which was to increase the velocity of the tidal current. This deepened the ground under the bridge; and the piers being thus deprived partly of lateral support, and some of the fine sand also getting from under the caisson bottoms, they began to be restless again."

The cause of the original failure in 1747 was the omission of driving piles under the piers; but the miserable economy of saving five or six thousand pounds, for which Mr. King (whose name ought to be thereupon preserved in honour) offered to execute the work, prevailed; though it was "not one part in 60 or 70 of the whole expense of the bridge." (*Gephyralogia*, pp. 96, 97). Hence, the first failure; and hence all the subsequent weaknesses of the structure, and the enormous expense of makeshift repairs.

When engineers like the late Mr. Telford and the present Mr. Walker suggest a remedy for an evil, occurring in the line of their own profession and in matters daily under their eyes, those who have not the advantage of their science and experience ought to be slow to pronounce an opinion unfavourable *a priori* to any suggestion so made. Mr. Telford recommended, that, as piles had not been originally driven under the piers, "piles should be driven round the piers, using the diving-bell for placing them and cutting them. A number was done in this way; but even those that were done did not seem quite at rest; and the commissioners, from the expense, uncertainty, and delay with which the operation was attended, seemed, before I was called in" (said Mr. Walker in his evidence), "to have resolved, for a time at least, not to enclose any more of the piers in the way I have described." Then came the system of coffer-damming. "My decided opinion is that coffer-damming is the best plan:" and that plan was thereupon adopted; but while Mr. Walker discontinued Mr. Telford's use of the diving-bell, and did not concur in Mr. Cubitt's plan of paving the bed of the river, Mr. Cubitt, on the other hand, equally condemned the use of coffer-dams in the case of Westminster bridge; stating distinctly "That in the case of Westminster bridge, the original construction and present state of the foundations are such as will not admit of the coffer-dam plan being carried into effect with safety to the bridge, or a well-grounded certainty of a successful result." Between these two discordant authorities, the commissioners made their election, and adopted Mr. Walker's plan of coffer-damming, and in the course of the following year entered into contracts for completing it.

It is due, however, to both gentlemen to state that, even in 1837, they each recommended a new bridge, if the pecuniary means could be found, in preference to any attempt to repair the old structure. Mr. Cubitt stated "That there is no doubt but a new bridge would cure all the evils complained of." And Mr. Walker enumerated those considerations, which "would probably turn the balance in favour of the new bridge." At a later period, the committee of 1844 received from that gentleman this further statement: "Without hesitation I say there is no art that can make the piers of this bridge so secure as I could have made a new one." Nevertheless, upon a review of all the case, he added: "I did not doubt as to the security of the whole superstructure. When I say this, I must at the same time allow, that the sinking which has taken place in the 17-feet east pier, after the water was admitted within the coffer-dam, is a drawback," meaning, of course, the only drawback, "which has at all raised a doubt on my mind;" a sinking, be it remembered, which has gone down nine inches, and has left that pier three inches out of the perpendicular: "but ever since last October th at pier has been, as every other part of the bridge has been, perfectly motionless: and therefore I have reason to think that the cause which created that movement in the 16 and 17-feet piers is at an end, and that these also are secure." At this time, the 16-feet pier had gone down two inches, and the 17-ft. pier nine in.: "all the piers," indeed, "sunk a little during the operation of driving the piles."

The confidence, however, or to use Mr. Walker's words in another place, "My faith, which amounted to conviction previously," (*i. e.* to the sinking in October, 1843), "was somewhat shaken" by that sinking; but he adds, "it is proper also to say, that my confidence has revived, by the entire freedom from all movement since that time," viz. up to the date at which he was then speaking, 10th June, 1844. If, however, the confidence revived solely because the piers had ceased to sink, it must, of course, die again when they again begun to sink. And this is the fact. The sinking has begun again; and, though in no one week considerable, or indeed observable except by very nice tests, yet the aggregate sinking in the course of many weeks becomes perceptible to the eye; and above all, as it is pro. gressive, must, at some period, terminate in the destruction of certain portions of the bridge, even if it do not endanger the whole fabric. So early as 1837, Mr. Walker's recommendation to the commissioners, as already seen, had bees to build a new bridge, if the funds could be obtained. On the 7th May, 1845, he stated to the commissioners, still more strongly,—"to the reasons I then gave for recommending the new bridge, there is to be added the bad foundation which has caused the sinking in the two piers; for even half an inch in two years is enough to prove the want of perfect stability, and to weaken that confidence which I ought to feel in order to justify my recommending an outlay of £100,000, in addition to the £90,000 already expended. I have before stated, that all the othe piers, which have been finished, are secure; but two piers on the Surrey side next to the defective piers, remain to be coffer-dammed round and, piled; and if the sand under those two be of as loose a nature as those adjoining, they may cause further trouble and expense. Should they require to be taken down, the difference between the partial plan" (*i. e.* continuing the system of repairs) "and the entire renewal" (*i.e.* the removal of the old bridge and the construction of a new bridge) "will be considerably lessened." The causes which induced Mr. Walker to recommend a new bridge in 1837 and in 1844 and in 1845, have not ceased to operate. The sinking in the 17-feet pier since the 7th May, 1845 to the 19th May, 1846, has been 1¾ inch, and in the 16-feet pier about 1¼ inch; and it continues in both. By the report of Messrs. Walker and Burges to John Clementson, Esq., Secretary to the bridge commissioners, dated 20th July, 1846, those gentlemen state that they have this day taken the levels of the piers of Westminster Bridge, and have to report a further sinking of $\frac{3}{10}$ths of an inch In the 17-feet east pier, and $\frac{1}{10}$th in the 16-feet east pier, since their report of the 6th instant." [6th July, 1846.] They go on to say, "The movement of $\frac{3}{10}$ths of an inch in the 17-feet pier is double what we have had occasion to report for a considerable time. The continued sinking in the two piers has affected the stones of the 72-feet arch which rests upon them, an open joint being perceptible in the soffits between two of the courses near the crown, and one of the south-face stones having dropped down about half an inch." Messrs. Walker and Burges concur, accordingly, in the statement, "that a way or thoroughfare over the river at Westminster, consistently with the safety of the public, can be best secured (or perhaps we ought now to say can be secured *only*) by a temporary bridge; and that no time should be lost in proceeding with it." More than a month earler (11th June, 1846), Mr. George Rennie gave, in substance, the same opinion, namely, that no time should be lost in making arrangements for the construction of a new bridge; and being asked, "Might not the present bridge serve as a temporary accommodation while another bridge is being constructed?" he replies, "It might;" but he adds, "*with all the chance belonging to it.*"

It is true that Mr. William Cubitt, the contractor, whom your committee felt it to be their duty to call as their first witness, inasmuch as the progress of the New Palace was a matter, as has already been observed, of comfort and convenience to the two Houses of Parliament only, whereas the safety of the bridge was of paramount importance to hundreds of thousands of the Queen's subjects, stated in answer to the second question, "I do not apprehend the bridge to be otherwise than safe." * * "I do not mean by that, that it is in a state of perfect stability; that there may not be from time to time slight settlements in it; but I am very strongly of opinion that no settlement will ever take place to a degree that should endanger the public safety."

The same witness, indeed, had stated in 1844, that he thought the bridge may last for two or three centuries:" "that the bridge, with a very moderate repair from time to time, is capable of carrying the public safely for centuries to come;" and he added, accordingly, "I know no reason why it should be pulled down."

On the extent, however, of the knowledge of the witness as to the facts connected with Westminster Bridge, it is due to the other gentlemen who gave a very opposite opinion, to state, that Mr. W. Cubitt, being asked whether he can state the depth of the river at Westminster Bridge now, as compared with its depth before the removal of old London bridge, answered, "I cannot;" and being further asked, "Have you ever understood that it has already (1844) deepened as much as five or six feet?" replied, "I have never hard such a thing: if that has been stated, it can only be in one particular place, where, from some cause or other, there has been a gullying ont by a peculiar current:" and when again asked, "You are not, however, aware of the depth which has been given to the river by the removal of old London bridge?" he replied, "I am not aware of it; but I am pretty sure that it has not given an average of 18 inches." The committee understood, of course, that in this answer Mr. W. Cubitt was speaking at the time of the locality in question, namely Westminster Bridge, and not of the Thames at Staines or Wallingford; and therefore proceeded to put the following question: "You conceive that anything less than an average of five or six feet would not endanger the security of the sheet-piling round the piers, by which they are surrounded?" to which Mr. W. Cubitt answered, "I rather hesitate in giving the precise line: if it came to five or six feet I should begin to feel uneasy, if I was sure it ever came to that." It appears, by sections of the river taken by Mr. George Rennie, and laid before this committee, as furnishing a very curious and interesting view of the changes produced by natural causes in the bed of the river, that between 1823 and 1835, the river, 50 feet below Westminster Bridge, had deepened between six and seven feet; proving the tendency of the river to "engineer for itself," to use Mr. Page's expression, to a greater degree than was previously anticipated; and this measurement near Westminster Bridge proves that the very case had happened which, as Mr. W. Cubitt stated, would have made him "begin to feel uneasy," namely, that the bed of the river had there deepened at least five or six feet: it fact, it has done more, inasmuch as, "by a longitudinal section of Westminster Bridge which appeared in Appendix 15, G. 1, to the Report on the Thames Embankment, and upon which," said Mr. George Rennie in his evidence, "I have coloured by a dark line the existing bed of the river in May 1846, it will be seen that the sixth and seventh piers from the Surrey side have their foundations exposed eight or nine feet."

On the whole subject of the effect which the deepening of the river or any other cause may have had in unsettling the foundations of Westminster bridge, and consequently its superstructure, the committee feel it to be their duty to recal two circumstances to the attention of the House: first, the settlements which did take place in the autumn of 1843, which, as already noticed, caused the bridge to be closed and shut up for carriages during a portion of the winter following; and secondly, that the favourable answers already quoted as to the stability of the whole structure, depend on the assumption that the whole structure is to be subjected to the same process and system of repair which has already been applied to parts. Now, the amount of the contract—remaining so to complete the repairs—was, in 1844, £52,870, together with a further sum of £40,000 to make the bridge of the same width as London bridge. This aggregate of £92,870 was therefore necessary, in 1844, according to the then views of the commissioners, to the repairs of the existing bridge; and might have been saved accordingly, and made applicable to the construction, in part, of a new bridge, if the repairs had been then discontinued, and if a new bridge had then been substituted.

In addition to this, it must never be forgotten, that Mr. W. Cubitt being the contractor for the works commenced in 1838, gave evidence as strong as that of any other witness, on the question of the original vice of the foundation. In 1844, he referred "to the original defect in the surface of the foundation;" adding, "I mean that it never was correct and proper." "There was one pier which had always been called the sunken pier; that was the one they were obliged to unload when the bridge was first built. Then these two other piers in the bridge which were called sinking piers: they had that name given to them because they had been in the habit of sinking more than others." And being asked, in reference to a subsidence of nine inches in one of the piers, whether such subsidence shakes his belief in the future stability of the foundation, he replies, "I always had an impression that the bridge would be liable to sink a little;" and being further asked, whether, "When you say 'a little,' do you consider nine inches a great or a small subsidence?" he replies, "I consider nine inches to be a great deal; but with reference to an arch of that form and with stones of that thickness, it is of very little importance with regard to the safety of the bridge." While, however, Mr. W. Cubitt states, that, so far as the original defectiveness of the foundation is concerned, the bridge is sufficiently stable for all purposes for which it is required, that no disaster ever can accrue by which the public would be damaged from that cause, he does not retract his preceding opinion, "that the bridge always must be an imperfect structure" in reference to the mode in which it was built; and, though he may contradict the opinion of others, he cannot gainsay the fact, that the bed of the river has been gradually deepening, and the foundations of the bridge abraded and laid bare in consequence; and the committee feel, that if this be so, Westminster bridge cannot be "as stable as it ought to be.

The very remedies, indeed, which have been applied to strengthening the foundations of the piers may in fact have loosened them, by loosening the ground on which they rested. Even so early as the 16th of May, 1823, the late Mr. Telford himself admitted, in reference to his own suggestion of sheet-piling, "I believe I did not sufficiently explain that by driving piles through loose sand and gravel, that the matter is always disturbed, and, during the operation of driving, liable to be washed away, and of course produce more risk to the piers than if left undisturbed." And Mr. W. Cubitt being asked, as the contractor engaged on the work, "Can you state to the committee whether it be or be not the fact, that every pier, as has been alleged, with only one exception, sank, more or less, after the sheet-piles round it to secure the bottom of the caissons from being underwashed by the general deepening of the river, were driven?" Mr. W. Cubitt replies, "they have not all sunk;" and being thereupon reminded "The question implies that one was an exception; do you wish the committee to understand, that all the piers, with one exception, have sunk more or less since the piles were driven?" Mr. W. Cubitt answers, "I am not prepared to state positively that they may not all of them have sunk a little. I am not quite sure but that they may have sunk an inch or half an inch, or some very slight thing; but one of them sank nine inches, and another sank two inches." And as to the future, Mr. W. Cubitt had already stated his previously formed opinion, that the bridge was not in any part of it in a state of perfect steadiness; that it might always be liable to subside a little, from the defect of the foundation."

The result of the whole question connected with this species of repair is stated by Mr. Walker in answer the question, "Do you think that the bridge will now be brought to a state of as perfect security and stability as a new bridge, if you were called upon to construct it?"—"Certainly not." And in answer to the next question, "Do you think that by any resources of your professional art, this bridge can be brought into a state of perfect stability and security as compared with a new bridge?" Mr. Walker replies, "Without hesitation, I say, there is no art that can make the piers of this bridge so secure as I could have made a new one." It is right, however to add, that Mr. Walker stated, in his examination this session, "that the measures which had been adopted had been completely successful in preventing any further movement in six of the piers: * * there has been no movement since" (*i. e.* since the 7th of May, 1845,) "in any of the piers, except the two I have already referred to." Nevertheless, in answer to the question, "Are you, or are you not of opinion, that with a due regard to the public convenience, and to avoid danger, arrangements should be made, without loss of time, for building a new bridge?"—Mr. Walker's answer is distinct: "Certainly, without reference to money, I say 'Yes.'"

As to the mere durability of the bridge, by which the committee understand the perfectness of the masonry both in the arches and in the piers, excluding always the question already discussed as to the stability of the foundation, there appears no reason to doubt the accuracy of Mr. Walker's opinion: "There is no part of the work which will not last for ages;" but a qualification to this opinion must here be given on the authority of Mr. Walker himself, who, in 1837, stated as follows:—"From the piers being intended originally to carry a wooden bridge, and being cased round when a stone bridge was resolved to be substituted, and *from the very bad quality of the masonry*, the superstructure never can be made a very secure and solid work;" and even admitting the superior accuracy of his later opinion, when, during the interval, he had had fuller opportunites of examination in relation to the durability of the superstructure of the bridge, it is obvious that this admission does not at all establish the expediency of maintaining the present bridge so long as the first and main question, as to the sufficiency and stability of the foundations on which the structure rests, remains in a state so unsatisfactory as at present.

It was not contended in 1844 that the bridge was then in a "perilous' state: Mr. Walker expressly repudiated the word; and, even before the new system of repairs, he had stated, "that the bridge is not in immediate danger;" and W. Cubitt, Esq., the civil engineer (and not the gentleman of the same name, who is the contractor for the bridge), being asked, in reference to the state of the bridge when the repairs should be completed, "Your conclusion is, that the bridge will be an insecure bridge?" replied, "A very doubtful one." "You will not say it will be an insecure bridge?" —"No." He had been previously asked, "Do you regard it possible, with any talent and any expenditure of money, to make the foundations of Westminster bridge as secure, under existing circumstances, as the foundations of a new bridge could be?" replies, "Certainly not." Mr. Cubitt, C.E., further states, that "from what I have seen, I would rather build a new bridge than spend more money upon this, seeing it has done exactly what I expected it would do when I made my report in 1837. My opinion is, that it is best not to go on spending a great sum of money to repair and widen and beautify this bridge, which never can be good, either in its roadway or in its foundations." Therefore, under all the circumstances, the bridge having proved to be too heavy for the nature of the clay it stands upon, it being very difficult to protect it without piling and paving, I say, as an engineer, that the best thing is to dispense with all further repairs, and make a new bridge. I said so before, and Mr. Walker said so also, and I am confirmed in that by what has subsequently taken place." And when asked in the next question, "You consider the only question to be one of finance?" he replies, "Certainly; the bridge is a mass of rubbish. The piers and the masses of masonry and rubble were first built for a wooden bridge, which was afterwards converted into a stone bridge, and heavy arches were put upon that which was not more than strong enough for a wooden bridge." * * The small piers were then cased round to make them larger; and springings were made for stone arches, and a very heavy bridge was put on those foundations."

Though Westminster bridge so constructed,—without piles and on the imperfectly-levelled natural bed of the river,—did actually fail during its construction, yet, "after it was constructed, and the arches which had failed were rebuilt, it stood for some 60 or 70 years unmoved." * * On the removal of the dam caused by old London bridge, "a wider passage was opened to the Thames, and the foundations of the arches underneath Westminster bridge began to wear away; so much so, that they caused a great apprehension of the bridge falling; and from time to time they were repaired by the diving-bell, and various other modes. Mr. Telford was called on, and advised stones being thrown in; and he advised also to pave underneath the arches between the piers, so that the bottom might not be washed away. After his death, the commissioners did me the honour to call upon me to advise them. I considered the thing, and felt quite aware that disturbing the bottom would not be a good thing; but that if we could continue the bottom exactly as it always was, the bridge would stand the same as it had done; that there would be nothing to prevent it; and to do that, I propose to pave with large stones, two feet thick;" * * * "to pave a perfectly flat floor down as low as the frames which form the foundations, and have been carried into the soil." * * * "I proposed, paving under the whole of the bridge, and 50 feet parallel along it, above and below, so as to make a perfect stone pavement; with such pavement the bottom never could have washed away; and without washing away, the piers would not have fallen down."

A suggestion made by such an authority as Mr. Cubitt, C. E., is of course entitled to just attention; but your committee, after bestowing that attention upon it, feel bound to state two objections to it, which, in their judgment, are insuperable. They relate to the effect of the plan upon the navigation, and to its cost. The one may be conveyed in the admission of Mr. Cubitt himself—"The only disadvantage (if disadvantage it can be called) of this plan is, that it limits the depth of the navigation under the bridge to the level of the stone paving; but as this would be greater, by about three feet, than originally existed, and till after the removal of the old London bridge, I imagine that no complaint could arise on that head." * * The answer to this observation is, that those concerned with the state and probable condition of Westminster bridge have to deal with the river, and its actual depth in 1846, and not with its depth in 1823; and must not forget that if the river has deepened under the arches, say six feet, the proposed plan of raising a pavement of something like three feet, would take away a depth of three feet from the actual navigation. The second objection is, that irrespective of all repairs to the bridge; and leaving that bridge as it is, the probable cost of the paving would, in Mr. Cubitt's own opinion, be about £120,000. It is not necessary, therefore, to pursue this subject.

Another remedy was proposed by another gentleman, Wm. Hosking, Esq., architect and engineer, and professor of the principles and practice of architecture in King's College, London. While he differed from other witnesses on some important points, and specially in his belief that "the present foundations might be rendered sufficiently secure to be entrusted with a new superstructure, especially if the superstructure was not an unnecessarily heavy one," he concurred with almost all in the opinion that the present bridge cannot be made "permanently available," to use his own words, "without the bar or weir I have spoken of, which I consider to be an absolute essential to the security of the existing foundations." Now, inasmuch as the bar or weir in question is, in the judgment of the same witness, a necessary precaution "at the other bridges" also, as otherwise "all the other bridges will be undermined as well as Westminster bridge," it is clear that his remedy must be viewed in relation to the whole of the river as it flows through the metropolis; and irrespective of the objections to which the plan, if ever adopted in any one breadth of the river, would be liable as an obstruction to the navigation at that part (which, even the witness admits, "it certainly would not improve,"), and so on, wherever adopted, the ultimate expense of making successive weirs above each bridge would be obviously immense; and the committee—to confine themselves to the consideration of this project in relation to Westminster bridge alone, the immediate subject referred to them—cannot recommend any further attention to it.

However wonderful as a structure Westminster bridge was regarded at the time of its erection, and there is reason to believe that at that time it was the longest stone bridge which covered water all the year round, not in England only but in Europe, Mr. Hosking expresses an opinion, in which your committee fully concur, "that a bridge, in every respect better, would be produced at the present time by almost any man of moderate ability, who is conversant with the subject."

On the general subject, both of the present state of the bridge and of the expediency of subsistuting a new one, other professional gentlemen, of the first character for skill and for experience, give evidence to the same effect.

Mr. Rendel states, "I should be very indisposed to risk any professional reputation upon giving to the present structure that permanent character which is adverted to."—"The foundations are wholly different from the foundations of any other bridges across the Thames."—"I do not believe that any talent or any skill, or any application of that skill, could, at a cost which I should call justifiable, give to the present bridge that security which its importance demands."

Mr. George Rennie states, "I should decidedly condemn the old one (the bridge), and recommend the expediency of its being taken down, regarding it as an engineering question entirely."—"Setting aside that (*i. e.*

money), I should condemn the present bridge decidedly, and have a new bridge; not only that, but you may be liable to very considerable further repairs besides those at present contemplated." – "I have no other observation to make, but that I consider it a great pity to devote that money to the repairs of an old structure which might and ought to be devoted to a new one, on the ground of the insecurity of the present bridge, and that there is no safe guarantee for the money laid out upon it being properly spent." In his evidence before the present committee, Mr. George Rennie stated that he retained precisely the same opinion: "I think it would be throwing away good money after bad to attempt to repair the bridge so as to make it a permanent structure." The removal of from 20,000 to 30,000 tons, as stated by Mr. James Walker in 1844, in order to lighten the vertical pressure upon the piers, by means of the abstraction of that material, has, in Mr. George Rennie's judgment, not succeeded in preventing the further subsidence. In fact, the further subsidence is stated distinctly in the evidence of Mr. James Walker this session.

The committee could readily extract, for the more easy consideration of the House, numerous other passages in the evidence of 1844; but they have perhaps sufficiently selected some of the most striking answers which have been given to the inquiries made on the subject of Westminster bridge; and they leave the remainder, without further selection, to the attention of the House. But they cannot conclude this collection of extracts from the evidence of 1844 without adverting to the fact, that the witnesses who depose the most explicitly to the propriety of removing the existing bridge are men of the highest engineering talent and experience in the empire; while the only witness, however excellent and respectable in his profession, who gave in that year any testimony in favour of maintaining the present structure, is the contractor employed to repair it.

Mr. Walker, while, as already stated, be repudiated the word "perilous," as applied to the bridge, distinctly stated that the want of money for a new bridge would alone induce him to propose the continuance of the actual structure.

When examined in the present session, Mr. Walker admits that, so far as regards one of the piers, "My opinion of being able to make the bridge perfectly secure, has not been a correct opinion, as far as it is shown at present. There is to be set against that, the expense to which the commissioners have been put, in repairing and strengthening the other piers; but, on the whole, my opinion is now, that, but for the question of expense, the better way is, under all circumstances, referring to the improvement of the situation, the future stability of the work, the giving an easier approach, an easier inclination, a wider bridge, a better water-way, and an improved navigation by a smaller number of piers, the safer and better course is to rebuild the bridge."

This answer well embodies the chief considerations which induced the committee to recommend, by unanimous resolution, the removal of the existing structure, and the substitution of an entirely new bridge.

Other considerations, however, have not been without their weight on the minds of the committee in the resolution which they adopted. The traffic over Westminster bridge has greatly increased within the last few years, "so much that it is difficult at times to get over it." It is obviously immense. Sir James M'Adam stated, in 1844, that he had been directed to cause to be counted the number of horses which passed Charing-cross annually, and that it had been ascertained that it was 6,600,000; and though there was no record of the proportion which passed over the bridge, he added, "I consider that the larger proportion of that thoroughfare, particularly the heavier carriages, passed over the bridge." It is stated further in evidence, that the inclination of Westminster bridge was in 1844 probably greater than that of any bridge over a tidal river in England; that its inclination was, at its commencement, *i. e.* for a distance of 50 yards at each end of the bridge, about 1 in 14½, and about 1 in 33 for the remainder. It is true, that the inclination has been reduced since 1844, but it has been reduced by the sacrifice of a quarter, at least, of the carriage-way of the bridge. As a general principle, it is clear that the wear and tear, both of the animals which draw a carriage on a steep inclination, and of the surface of such inclination itself, must be considerably greater than on a level, or than on any road-way in proportion to its approach to a level. When, in addition to this, it is recollected that, in the course of the system of repairs recently adopted, and for the purpose of lightening the vertical pressure on the bridge, such a mass of stone has been displaced as has reduced the present surface of the road by a depth of five steps below the footpath, on both acclivities, and that the carriage-way has thereby been contracted about the width of a carriage, it is sufficiently evident, that almost in the measure of the increase of the traffic has the accommodation for its passage over the bridge been diminished,

When, further, it is recollected that the headway under the existing Westminster bridge is lower than the headway under any of the bridges in the metropolis, and until reaching Battersea, it is clear that, as favouring the navigation of the river, it has no special claims to consideration.

New Bridge.

The committee of 1844, whose report has been referred to the consideration of the present committee, took evidence on the question, whether, in the event of its being decided to pull down the present structure, and to erect a new bridge, the material should be of iron or of stone; and if of iron, whether in suspension or in the form of arches; and if of stone, whether of granite or what other material. And the committee, in the present session, examined at some length both Mr. George Rennie and Mr. J. Walker, on this general subject. The committee do not feel it necessary either to analyze this evidence, or to come to any formal conclusion on the subject, except to recognise the two following propositions, namely, (1) that a suspension bridge, though affording greater facilities to the navigation than any other form of bridge, is inexpedient; and (2) that irrespective of expense, a granite bridge is expedient. On the first point, Mr. George Rennie compressed into one sentence the whole question:—"The great inconvenience of suspension bridges is, that they are always at work, that they are always in a state of degradation; whereas, bridges by compression are always in a state of equilibrium." The illustrations which he gave will well repay the attention of the House. On the second point, it is clear that, in proportion to the strength of the material, may be its thinness; and a greater waterway can be afforded by an arch of granite than by an arch of Bath stone. From this gentleman, from Mr. Walker, from Mr. Barry, and from Mr. Page, the committee have received designs for a new bridge, and have directed them to be lithographed. All have great merit; and perhaps the one which possesses the least might, if it stood alone, have satisfied every requirement. But the committee do not feel it within their province to give any opinion on the relative value of these productions. They do not, however, consider it to be inconsistent with their duty to recall to the attention of the House a suggestion applicable to the erection of all public works; it was made to the committee of 1844 by a gentleman already cited, who appeared to have given particular attention to the subject. The substance is stated in the next paragraph.

Competition Designs.—On the mode by which competition might best secure the application of the first talents to the production of the best designs, and might thence enable some superior authority to select one from all, or to combine different parts from two or more, Mr. Hosking stated as follows (and the committee concur generally in his opinions):—The essential matters should be defined by the proper authorities, in the first instance, and before attempts are made to obtain designs. A specification of what is required should then be made; and this should be more or less particular, as it may be determined either to fix a sum of money as the limit of expense; or, on the other hand, to receive designs with reference to the object and without limiting the expense. Such a specification should be put into the hands of a reasonable number of competent practitioners, with a request that they would each make a design for the contemplated work in accordance with the stated conditions. All the designs so obtained may be examined and investigated with the advantage of the presence of their authors to explain what they may have intended, and to correct what may be misunderstood. In this manner the best energies of competent men would be applied to the work, and it is probable that the best result would follow. * * * A general competition would end in general disappointment; * * * as none of the persons who would be recognized as most competent, would send designs without being specially applied to for them. * * * At the time London bridge was in contemplation, advertisements were issued for designs, with offers of some three or four premiums. Drawings were sent accordingly by 70 or 80 persons, and the premiums were awarded to the three or four which were said to be the best designs; but not one of them was used; they were immediately thrown away, and a design was taken up which had not been in the competition; but which, indeed, had been in the hands of the bridge committee beforehand, and the author of which was already dead. The late Mr. Rennie's design was executed. In order to avoid this apparent invidiousness and unfairness, and to secure the real benefits of a competition among competent men, the selection of the architects and engineers should be limited; and each should receive a certain remuneration for the work which he might send in. No man can afford to work for nothing. Every design asked for should be paid for; and no one ought to be asked, either directly or indirectly, to make a design, unless it be intended to pay him for it. If this system were adopted, the property in the designs so sent in would belong thereafter to the authority, by the directions of which they had been sent in; so that the good parts of one design might be accommodated to the good parts of other designs, and the combined result of the whole would be something superior to that of any one individual design. This is one of the advantages from requiring designs from persons of known ability, and paying for them, so that all the designs obtained may be turned to account. It is the parties seeking designs, and who desire to derive advantage from the application of many minds to the same subject, that are to be benefited; and they who seek a benefit must be contented to pay for it. It can never happen, but that in several designs for the same thing there will be some points or parts in some of the designs, other than that which may be generally the best, better than the same points in the best design. When all are paid for, all may be used; and the best design in a "concurrence" may be greatly improved by the incorporation of the excellencies of the others.

Site of the New Bridge.

The House will observe that the committee, in their resolutions herein adverted to, have not pronounced any opinion as to the precise site of the new bridge; but it is obvious that, while many considerations might be urged for the removal even to a distant position, other considerations, entitled to the highest attention, might be adduced in favour of the existing line, or one in immediate juxta-position to it. It has been suggested by a high authority that it would be very desirable to remove the bridge to the south of the Victoria Tower, thereby opening a more direct communication from the region of Belgrave-square to the right bank of the river, and generally to Lambeth, Southwark, and London bridge, and the railway termini now established in its neighbourhood, or hereafter to be so established. It has been also suggested, as a consequence of such removal of Westminster bridge, that a new bridge might be thrown over the Thames at the east of Whitehall-yard, with an access from Charing-cross, and another access from the Horse Guards. But independently of the objection, more or less valid, of disturbing the present traffic from Charing-cross to the north, and from George-street, the rest of Westminster, and the parks to the west, the committee think it right to refer to the evidence of Mr. Rendel in 1844: "I do not believe that there is a part of the Thames better suited for a bridge, by which I mean a permanently founded bridge, to stand upon, than the site of Westminster bridge." It is right to add, that the approach to the actual bridge from the left, or Middlesex bank of the river, is carried along Bridge-street, almost the whole of the property on the north side of which is part of the bridge estates; and therefore, that a new bridge, on the existing site, would be erected with little sacrifice of that property; and that a new bridge erected to the north of the present structure, that is, further down the river, and at a better point of view for regarding the New Palace, need involve no other sacrifice of the bridge estates than that of the ten houses forming part of the north side of Bridge-street, and without any considerable outlay in the purchase of the other houses on the same side. In connexion with this consideration, it was at one time assumed, that, though there was no prospect of permanently preserving the present bridge, it might, nevertheless, continue available for the temporary passage over the river, while the new bridge was in the course of erection in juxta-position to it on the north. But Mr. Walker urged, in the spring of 1845, the erection of a temporary bridge as even at that time desirable; and he has urged it with increasing earnestness in the course of the present examination. He estimates the first cost of a temporary bridge, of which he has prepared a plan, at £40,000; and be considers that a certain portion of that expenditure might be recovered by the sale of the timber forming the materials of that temporary bridge, when the new bridge should be opened; and that the remaining portion of the cost of such temporary bridge would be met by the value of the materials of the existing bridge, if used up on the spot.

Estimate of New Bridge.

Your committee will now proceed to consider what means remain in the hands of the commissioners of Westminster bridge, in aid of the expense of a new structure; and what, in the first instance, is the constitution of the commission itself.

The management of Westminster bridge is in the hands of 94 commissioners: 26 sit by virtue of their offices; 57 by virtue of their seats in the House of Commons, as representing the metropolitan counties; and 11 sit as elected by virtue of the Bridge Act, 9 Geo. II. The annual expense of that management, irrespective of the expense of repairs, is in salaries:

	£	s.	d.
Treasurer	300	0	0
Clerk	40	0	0
Clerk of the Works	140	0	0
Sir James M'Adam for "coating the road," including a small sum to himself for superintendence	772	10	0
Police	169	16	0
Gas	65	0	0
	1,487	6	0

The general expenditure in connexion with the bridge from the 5th of April, 1810, to the present time, that is to say, to the quarter ending 5th of July, 1846, has been £190,221 15s. 10½d. There is a further sum remaining due to Mr. W. Cubitt, under his contract; and another sum due to Mr. Walker in respect to his per-centage. Probably, if the account could be closed at the date of this report, the aggregate charged and chargeable upon Westminster bridge would not be less than £200,000 from the 5th April, 1810, to the 5th July, 1846.

The sum actually expended is distributed over three periods: I. From the 5th April, 1810, to 5th April, 1838, when the commissioners began their great system of repairs and alterations in the structure and foundations of the bridge. II. From the 5th April, 1838, when that great system may be held to have commenced, to the 5th April, 1844, which may be taken as the period when the attention of a committee of the House of Commons was called to the question of the expediency or inexpediency of continuing that system. III. From the 5th April, 1844, to the 5th July, 1846, namely, from about the period when the said committee concurred in the expediency of continuing the system of repairs, and thereby encouraged the commissioners to proceed therein, to the period when the present committee, on a review of all the circumstances which had occurred up to the 15th July, 1846, unanimously, on that day, recommended the removal of the existing bridge and the erection of a new bridge.

	£	s.	d.
The sum for the repairs under the old system, and for management, &c. was for the first period	83,097	6	9¼
The sum for the repairs under the new system, and for management, &c. was for the second period	81,341	16	8
And for the third period	25,782	12	5
	190,221	15	10¼

In addition to this sum, in addition to the two items which remain chargeable upon the bridge estates for work already done, and for the percentage upon it, it must always be remembered that, in order to complete the great system of repairs commenced in 1838, two, at least, of the piers remain to be included in that system, at an expense proportionate to that of the others, and the widening of the bridge 12 feet to make it equal in width to London Bridge, that is to say, building a bridge 12 feet broad, in union with the existing bridge, on its south side, at a cost of £40,000, the aggregate of all which was stated by Mr. Walker, the professional adviser of the bridge commissioners, at £100,000, about the time when the works generally were discontinued on the bridge; namely, in the early summer of 1845.

The House will observe that the committee in their resolutions took the sum remaining to complete the repairs, and which might be saved and applied to a new bridge, if those repairs were discontinued, at no more than £70,000; they also took the amount which might be raised on the credit of the bridge estates, in aid of the fund for erecting a new bridge, at no more than £100,000;—in both cases preferring to understate rather than to overstate the facts on which their recommendation has been founded;—but, as they have placed on record the evidence, parole and documentary, which they received on the general subject,—the excess of charge which might remain to be incurred if a new bridge were not built, and the excess of assets, above the amount which they have been willing to take as available for a new bridge, if such new bridge be built, will be open to the judgment of the House.

The commissioners began the works with an amount of £51,124 19s. 6d. in the funds, and a cash balance of £4,299 0s. 10½d., being the accumulations of their income above their expenditure. Since that time, besides the expenditure of their current income, sales have been made, in order to provide for the repairs which they had undertaken. These sales have reduced the capital to £10,000 Consols, giving an income, after deducting the property tax, of £291 5s. The value of their estates was estimated by their architect and surveyor, Philip Hardwicke, Esq., in 1843, at £172,521.

The aggregate of this sum, and of the funded property, might almost have sufficed, according to some of the plans before the committee of 1844, to build a new bridge; or if not, at all events to have required but a comparatively small sum from the public Exchequer in order to complete the whole structure, as well as the approaches, of a new bridge.

It is right to recollect that the case of bridges in the metropolis differs widely from the case of those in the counties of the empire; not only inasmuch as all the Queen's subjects have a common interest in their resort to her capital, and a share in the fame which its aggrandisement reflects on all her dominions; but specially, because, perhaps from this cause, the State did, in fact, erect the only bridge which for centuries existed in London; and in the last century did create, directly and indirectly, by grants from the Treasury and by money raised by lotteries, the very fund from which the present Westminster bridge was actually itself built a hundred years ago. If, therefore, it be said, that the nation does not erect bridges in the county towns of England, or did not erect the other existing bridges in the metropolis, it may be replied, that the case of Westminster bridge, built in a large part by annual votes from the Treasury, stands on different and now exclusive grounds; that the structure has been adopted by the nation; and that when Parliament enacted,—see 9 Geo. II., c. 29, s. 20,—that it should be extra-parochial, and should not be a county bridge, chargeable either to Middlesex or Surrey,—see same Act, s. 21,—it sanctioned its claim to be national, and to be sustained at the expense of the empire.

The expense however of a new bridge, if a new bridge shall be deemed essential, will not, as already shown, necessarily fall on the State exclusively. It was calculated in 1844 that a sum of £172,521 could be raised on the credit of the bridge estates, irrespective of a comparatively small amount of funded property then in the hands of the commissioners: and even deducting from the number of their houses, those which would be required for the completion of a most magnificent approach on the Westminster side, if that site should be adopted, and indeed on the Surrey side also, there will still be left, in addition to the balance of the funded property, enough to raise at least £100,000

Resolution of Committee.—In this state of things, the committee felt themselves justified in coming to the resolution which on the 15th of July they adopted unanimously,—That it is expedient that the present bridge be pulled down, and that a new bridge be constructed; and it is further expedient that a Bill be brought into Parliament next session to transfer to Her Majesty's Commissioners of Woods, &c. the property of the bridge commission; just consideration being had to the claims of those officers of that commission whose services should be discontinued.

Partial Destruction of the New Locks at Bristol.—By the pressure of the high spring tide, on the night of August 9th, at Cumberland basin, the extensive works now in progress by the dock company, with a view to widening the southern entrace lock sufficiently to admit of the ingress to the port of vessels of the capacity of the Great Western and Great Britain, were seriously injured. In order to admit of the necessary excavations and erections, the flow of the tide had to be kept out of the lock in question, and this was sought to be effected in the usual way, by driving double rows of piles and loading the interstices, so as to form powerful dams.

ON THE PROFESSIONAL EDUCATION OF THE ENGINEER AND ARCHITECT, THE BUILDER AND MACHINIST.

The Classes of Architecture and Engineering at University College, under Professors Donaldson and Harman Lewis, closed on the 15th of June. The distribution of prizes, of which we were compelled last month to defer the notice, took place on the 1st July as follows:

In Architecture.—First year's course in Fine Art: Prize and First Certificate to J. Benwell; Second Certificate to F. Lawrence (see below). First year's Class as a science: Prize and First Certificate to G. P. Boyce and F. Lawrence, equal (see below); Second Certificate to B. J. Benwell (see above). Second year's course: Fine Art Prize and First Certificate to John Pollard Seddon; Second Certificate to W. Wood Deane (see below). Second year's course as a science: Prize and First Certificate to J. G. D. Allason; Second Certificate to W. Wood Deane (see above).

In Engineering.— Prize and First Certificate to F. Lawrence (see above); Second Certificate to — Mackenzie.

The advantages of the courses of instruction followed at this Institution must be obvious to every one. It has hitherto been too much the practice for young men in this country, in almost every department of professional knowledge except the medical, to neglect a systematic elementary course of education, and to rely upon the experience of actual practice to carry them through their arduous career. The consequence has been that men of an inferior rank in society, moved by greater energy of purpose, more self-denying habits and activity of mind, have devoted their spare hours to master the elementary branches; and thus having fitted themselves for great undertakings, have stepped forward and acquired reputation and wealth, while their more *genteelly* connected competitors have been thrown in arrear by the weight of the more solid acquirements of the humbler aspirants. Nay, we feel assured, that if, in the inferior ranks of construction and mechanical science, those connected with such pursuits as buildings and machinery would make themselves acquainted with the elementary principles of science, their inventive genius would receive greater development, obstructions would be more readily overcome, and they would find less difficulty in giving reality to their conceptions. In every department of knowledge there is now a great advance, and those, who wish to succeed in the contest for wealth and fame, must prepare themselves for the struggle by their superior attainments. The student, the apprentice, the mechanic, the foreman, the clerk of the works, may, in such courses as these, learn to regard their pursuits in a methodical system of instruction and reasoning. Commencing from first principles and masters of the elements, they proceed to the consideration of their application. The choice of materials, their applicability and adaptatation for economic purposes, are brought before them; a wide and comprehensive view of the world of science is opened; they acquire the habit of reasoning with precision and of a systematic consideration of objects; they have explained to them, in addition, the finest examples; they learn the history and progressive development of invention, with the names and characters of the most illustrious men; they are also made acquainted with the value and importance of the best scientific literary works. They are thus thoroughly grounded with a fund of knowledge, which the hurry of subsequent practical life forbids their ever acquiring, and which they cannot gain in the office of the professional man. It were idle to suppose that this system can supersede the knowledge to be gained under the architect, engineer, or builder; but it completes, at all events, the practical experience acquired on the works of the master: and the education of the young man being perfected by this combination, he is enabled to follow up his pursuit, the matured and well grounded architect, engineer, builder, or mechinist, and not with the raw inexperience of unskilled youth.

Both the Professors accompanied the classes during the session to works in progress, and explained the principles which directed the conception and execution. Professor Donaldson has had to acknowledge the liberal courtesy of the Deans and Chapters of Westminster and St. Paul's, they having granted unrestricted permission to the Professor and his pupils, to visit every part of those edifices, the examination and description of which occupied in each case many hours.

To give an idea of the habits of thought inculcated in the class rooms, we transcribe merely two of the questions out of the series which the students had to answer for the prizes; and we will ask, if the qualification to answer these does not presuppose a course of previous study of incalculable benefit to the future candidate for fame:—

"Take a review of the history of architecture from the third century of the Christian era, and investigate the influences which probably caused the modifications of sentiment perceptible in the edifices of the different epochs of mediæval art in various countries."—"Supposing that the expression of a leading principle in buildings may be distinguished, accordingly as the leading lines of the elevation may be either vertical or horizontal; examine this theory by reference to the edifices of ancient and modern art, and state under what class respectively should be ranged the monuments of Egypt, Greece, Rome, and the Middle Ages."

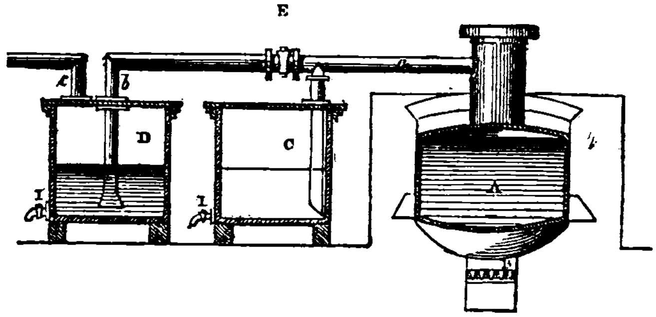
REGISTER OF NEW PATENTS.

If additional information be required respecting any patent, it may be obtained at the office of this Journal.

PURIFYING GAS.

John Robert Johnson, of Nelson-square, Surrey, chemist, for "*Improvements in Purifying Gas, and in the treatment of products of gas-works.*"—Granted December 20, 1845; Enrolled June 20, 1846.

This invention relates, first, to a new mode of purifying gas used for illumination, from those impurities which consist of ammonia and its compounds. The inventor effects the separation of the ammonia, by using the substances possessing the property of absorbing ammonia or its compounds in the dry, or more properly speaking, solid state, instead of in the state of solution, as has hitherto been practised. Among this class of substances are comprised, the solid acids, such as the phosphoric, boracic, and other acids; the salts with excess of acid, as the bisulphates of potash, of soda, and of ammonia, the biphosphates of these bases and other salts of this class; the salts of alumina, and of some other earths. Those substances which absorb the compounds of ammonia entirely, acid as well as base, entering into combination with the components of the substance used. The metallic salts, containing the requisite quantity of water, will serve more or less perfectly for the purpose required; but the salts of iron and manganese, from their cheapness, will be found preferable to others. These salts are reduced to powder, and used precisely as the moistened lime is used in dry lime purifiers.



The second part of the invention consists in a new mode of treating the ammoniacal liquor of the gas-works, for the purpose of preparing the salts of ammonia in a purer state than they have been usually obtained, and without the noxious exhalations which attend the ordinary mode of operating. The liquor is placed in a vessel A, similar to an ordinary steam-boiler, and heat applied through the furnace B. The liquor consists principally of hydrosulphuret and carbonate of ammonia, with small quantities of other salts of that base. As soon as the temperature rises, the hydrosulphuret of ammonia comes over, it being the most volatile product. A slow fire is kept, so as to volatilize this product exclusively, and during its passage is conducted by the pipe *a*, into the vessel C, containing a solution of some substance which has the property of absorbing the sulphuretted hydrogen and the deleterious gas, as the salts of iron and manganese. The product, after sufficient of the vapours have passed to saturate the material employed, is a solution of a salt of ammonia, holding in suspension the sulphuret of iron or manganese. In this plan, one vessel for holding the material through which the vapours are passed is sufficient, but if more be employed they are charged with the same solution. When lime or alkali is used to absorb the sulphuretted hydrogen, the ammonia is liberated and must be conducted into a second vessel D, charged with an acid. At the end of this part of the operation, that is, when all the hydrosulphuret of ammonia has passed over, the products found in the first vessel are sulphuret of lime and some free ammonia, and in the second a solution of a salt of ammonia. If the acid was but slightly diluted, the solution may be obtained saturated and fit to christallize on cooling. The liquid remaining in the boiler, and now consisting principally of carbonate of ammonia, may be treated in the ordinary way for preparing the salts, or the evaporation may be continued in the boiler at a higher temperature, in order to drive over the other volatile salts and the vapours passed through acid to absorb the ammonia. In the latter case the apparatus just described may be used, the cock E being opened. The vapours then pass through the pipe *b*, and through the acid in the vessel D, without entering the vessel C, containing the lime, and are then absorbed. The evaporation is continued until the volatile salts of ammonia are all driven off, when the liquor in the boiler may be rejected, unless it be found that the fixed salts remaining in the liquor are in sufficient quantity to be worth extracting, which may be ascertained approximatively by evaporating a drop of the liquor on a strip of glass, or accurately by evaporating to nearly dryness a known quantity of the liquor, and by weighing the resulting salt. These fixed salts may be obtained by entirely evaporating the liquor in a lead vessel, or by adding to the liquor, while in the boiler A, a certain quantity, more or less, according to the quantity of the fixed salts present, of sulphuret of lime in solution. This substance may be obtained from the first part of the operation when lime is used, or from the liquor of the wet purifiers of the gas-works. The sulphuret of lime decomposes the fixed salts of ammonia, liberating the latter substance in the state of hydrosulphuret, which may be treated in the same manner as that evolved in the first stage of the process.

STEAM ENGINES AND PROPELLERS.

John Seaward, of the Canal Iron Works, engineer, for "*Improvements in the steam engine, and in machinery for propelling.* Granted January 12; Enrolled July 12, 1846.—Reported in the *Patent Journal.* With Engravings, see Plate XIV.

Guide block.—The first part of this invention relates to a guide block (fig. 1) for preserving the parallelism of cross-heads of steam engines, and other machinery. *a a* are two guides, bevelled on both sides, forming angular edges, to which are fitted two sliding pieces, *b b*. *c* is a block fitted between the pieces *b b* and their respective lugs or projections, *d d d d*. Two powerful spiral springs, as shown by the dotted lines, are compressed within the block *c*, forcing the pieces *b b* against the guides, and in order that they shall not cause the friction to be too great it is furnished with two bolts *e e* on each side side, and thus regulated at pleasure; *f* is a hole for the reception of the cross-heads.

Plumber block.—Secondly, this invention relates to a plumber-block, to be used where the force acts longitudinally, or at an angle. It is fitted with two sets or pairs of brasses, one being divided longitudinally, the other vertically; the last-named are closed by keys placed vertically at the back; these are furnished with screws and nuts similar to the key of a connecting rod; the others by bolts, as usual.

Valves.—Thirdly, these improvements consist of an apparatus for working the valves of such engines as are fitted with a double set.

Fig. 2 shows a fore and aft vertical section of a cylinder fitted with a double set of slide valves; and fig. 3 an external side view of the same. *a* is a horizontal slide, which moves in dove-tailed grooves, *b b*, and is connected to the bent lever *c* by a rod, as shown by dotted lines. This lever works on a fixed fulcrum at *d*, the short end being connected in the usual way to the eccentric or other rod by which it may be worked. *e e e e* are four weigh shafts connected in pairs by the levers *f f f f*, and cross-rods *g g*. The levers A A A A on the weigh shafts are connected by links to the valve spindles, as shown in fig. 2.

Now, it will be observed that when the slide *a* is moved to the right by the motion of the engine, the tappet *h* will come in contact with the lever *i*, thereby closing the steam valve *j*, cutting off the steam at any part of the stroke according to where the tappet may be set, and partially closing the escape valve *k*, as shown in fig. 2. On the slide moving still further, the lever *i* will slide along the back of the tappet *h*, till it meets with the tappet *l*; this will entirely close the eduction valve *k*; the lever *m* will be acted on in a similar manner by the corresponding tappets producing the motion of the opposite valves as before described, when the lever *i* is moved by the tappet *l*. The toe *n* (fig. 4) is caught in the step *o*, and held in that position till relieved by the opposite toe *p* coming in contact with the corresponding step, which, it will be remembered, does not take place till the tappet *q* closes the eduction valve *s*, the weight on the weigh shaft bringing it smartly back to its original place; the spiral springs, *r r*, are for keeping the steps more effectually to their work. The tappets are fitted with regulating screws *t t*, for the purpose of altering their position so as to cut off the steam at any required part of the strokes. *u u* are rods by which the weights are hung on the weigh shaft to alter the valves for the return stroke of the engine.

Steam Pipe.—The fourth part of this invention relates to an apparatus for the better separation of the steam from the water in boilers, thereby preventing what is usually called priming; it consists of three circular concentric casings, *a b c* (fig. 5); they are attached to the upper parts of the boiler in the space occupied by the steam. *b* is fitted with a conical bottom, terminating in a pipe *d*, reaching nearly to the bottom of the boiler; the upper part of this casing is perforated with a number of small holes to admit the steam which passes up between it and the outside casing *a*, thence downwards under the inside casing *c*, where the water separates and runs down the pipe *d*; the steam again rising, passes off by the steam pipe *e* to the engine.

Screw Propeller.—Fifthly, this invention has relation to an improved method of shipping and unshipping, or in other words, raising and lowering screw propellers, and the means of fixing them to the shaft.

Fig. 6 is a view of the stern quarters of a ship fitted with these improvements. Figs. 7, 8, and 9, show some of the parts separately. *a a* is a swinging frame furnished with bearings and journals, in which the propeller revolves freely. *b b* are two sliding bearings to support the journals of the swinging frame, and guide it in its ascent or descent. The lever *c* is for swinging the frame on its bearings *d d*, for the purpose of placing or displacing the propeller on or from the shaft, which, it will be observed, is conical at the end, for its more easy entrance and removal. Fig. 8 shows part of the propeller shaft *e e* in section, having an internal shaft, the outer end of which is furnisheed with a screw *f*, the inner with a screw wheel *g*, gearing into a screw spindle by it turned round. The action of this is as follows:—The swinging frame and propeller being placed within the sliding pieces *b b*, it is lowered (by means of the chain and crab placed in the stern, as indicated by dotted lines) till, opposite the end of the shaft, the lever *c* is forced back; this will place the propeller on the shaft, and, by turning the screw wheel, the screw will enter the propeller, thereby firmly securing it. The reverse of this operation will unship the propeller. By another plan the swinging frame is dispensed with, in which case the shaft is supported by two stays, as seen at fig. 9, by dotted lines. The propeller is raised and lowered by means of two round bars, pointed and screwed at the lower ends, and placed in a vertical position immediately over two holes formed in the blades near the centre; these bars slide vertically in guides, and are connected near the lower ends by a yoke, which is attached to a crab by a chain, as shown in the last case; the boss is drawn on and secured to a conical wedge-shaped clutch on the propeller shaft, by the means before described; when it is desired to unship the propeller blades, they are placed in a horizontal position, with the holes before mentioned uppermost; the round bars are lowered and screwed into them; the shaft is then withdrawn from the propeller, and purchase applied to the crab, which will bring it above water under the counter of the ship.

The sixth and last part of this invention has also relation to propelling machinery, and is for the purpose of reducing the friction on the end thrust of the propeller shaft, by introducing a thin film or stratum of oil or water between the rubbing surfaces, which are of hardened steel. The face that receives the pressure from the propeller shaft is secured to some convenient part of the engine, or beam of the ship, and has a channel bored through to the centre of the steel face, which is turned concave about one-third its diameter, as also that on the end of the shaft. A continuous stream of oil or water is forced by three pumps through this channel into the hollow faces, and escaping at the circumference, where it is collected by a casing, is returned through a tube to the tank below the pumps; thus preventing the rubbing surfaces from coming in contact, and thereby reducing the friction.

Claim:—First, the forming of guide blocks of steam engines of three several pieces, having springs and adjusting screws, as before described.

Second, the improved compound plumber block, having two sets of brasses, one pair divided longitudinally, the other vertically, as before described.

Third, the working of steam engines having double slide valves, by means of horizontal slides having double tappets at each end, as before described.

Fourth, the adaptation of an apparatus to steam boilers, for the prevention or lessening of priming, as before described.

Fifth, the methods of connecting and disconnecting the propeller to or from the shaft, in screw-propelled vessels, as before described.

Sixth, the means of reducing the friction consequent on the end thrust of the propeller shaft, in screw-propelled vessels, as hereinbefore described.

PLATE AND SHEET IRON CUTTER.

William Vincent Wennington, of Goscote iron-works, Staffordshire, Esq., for "*Improvements in or improved methods of cutting plate and sheet iron.*"—Granted January 20; Enrolled July 20, 1846. With Engravings, see Plate XIV.

The improvements consist in the combination of a rotary and horizontal continuous movement, by which means plates of iron of any length may be cut without curling or buckling. The rotary movement consists of a circular cutter *a*, set in motion by the gearing hereafter explained and the horizontal movement of another cutter *b*, attached to the traversing table *c*, upon which the iron plate is laid. An alternate rotary motion is produced by the circular cutter *a* being fixed on one end of a shaft *d*, revolving in bearings fixed between the standards *e*, and over the bearings are regulating screws *f f*; on the other end of the shaft is a bevelled wheel *g*, which takes into either of the bevel wheels *h* or *i*, keyed on to the hollow shafts *j j*, and which slide on the main shaft *k*, set in motion by steam or any other known power. For the purpose of giving a horizontal movement to the traversing table, there is a cog wheel keyed on to the shaft *d*, immediately at the back of the cutter *a*; this cog wheel takes into the rack *l* and causes the table *c* to move on the Λ rails *m m*. On the under side of the table are tappets *n*, which act on a lever, *n'*, fixed on the small shaft *o*; and at the other end is a forked lever *p*, which acts on the clutch *g*, for throwing the bevelled wheels *h i* in and out of gear; thus an alternate backward and forward movement is given to both the revolving cutter *a*, the traversing table *c*, and cutter *b*.

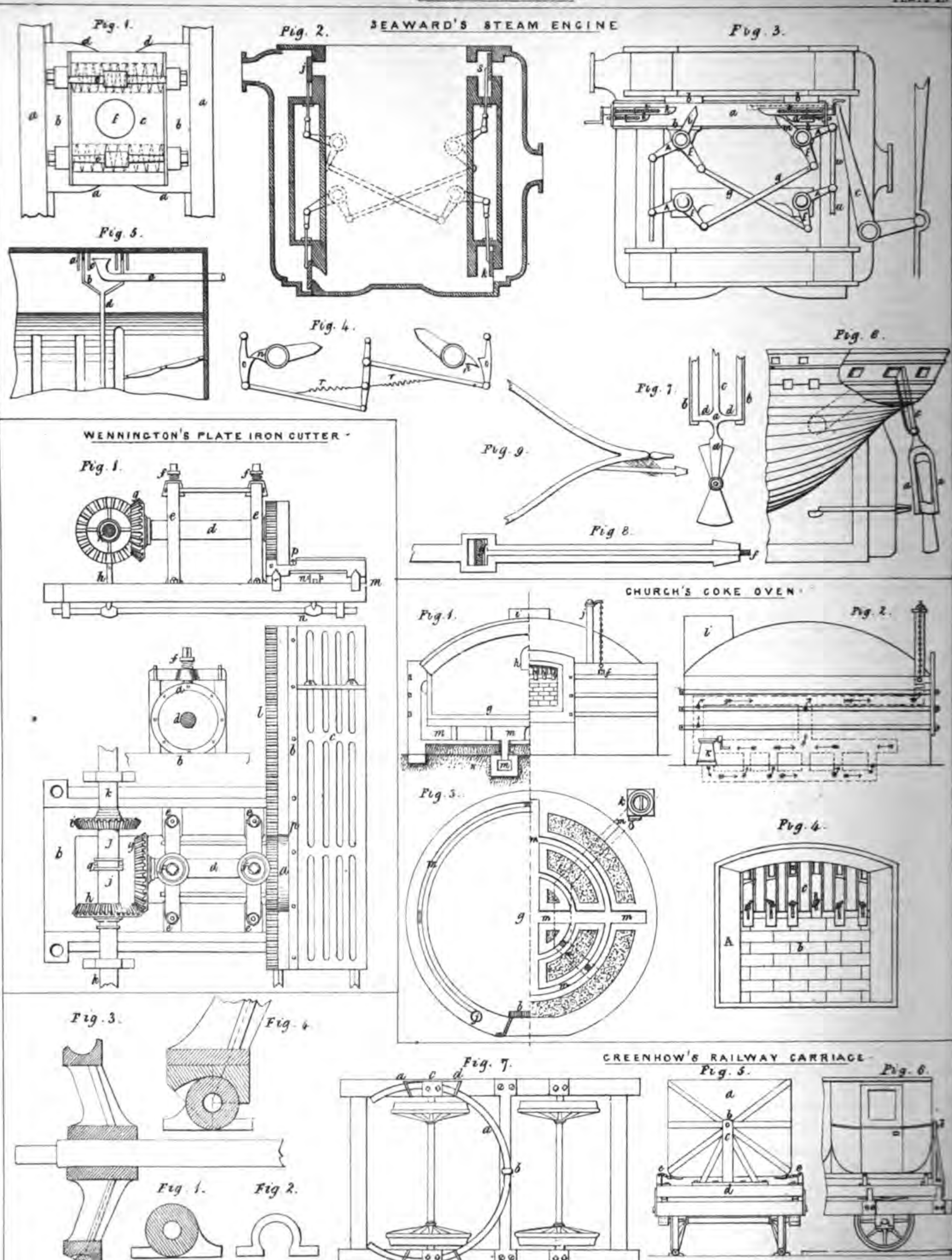
The claim is for the combination of a rotary and horizontal motion for cutting plate and sheet iron.

COKE OVEN.

Jabez Church, of Colchester, Essex, gas engineer, for "*Improvements in manufacturing coke.*"—Granted December 20, 1845; Enrolled June 20, 1846. With Engravings, see Plate XIV.

The improvements consist in the construction of coke ovens with regulators, valves, and flues for admitting cold air to the inside of the oven during the manufacturing process and to cool the coke within the oven at the end of the process. Fig. 1 shows one half of the front elevation and one half of the transverse section of a coke oven; fig. 2 the side eleva-

NEW PATENTS


SEAWARD'S STEAM ENGINE
WENNINGTON'S PLATE IRON CUTTER
CHURCH'S COKE OVEN
GREENHOW'S RAILWAY CARRIAGE

tion; fig. 3 one half of a horizontal plan of the cooling passages under the oven, on a level with the line Y Y, and one half of the plan of the oven on the line Z Z. The other half in each figure is similar in construction to the half shown in the engraving, and similar letters refer to similar parts in each figure.

A is the mouth-piece of the oven (see enlarged view, fig. 4) with a temporary wall of bricks *b*, built up as the coke is put in; *c* cast iron door with oblong apertures *d*, fitted with vertical slides *e*, for regulating the size of the apertures, or entirely closing them; *f f* are two passages on each side of the oven mouth, fitted with regulating valves and inclining upwards towards the top of the interior of the oven; *g* is the floor of the oven; *h* the flue leading from the interior to the chimney *i*. *j j* (fig. 1) are two vertical pipes with hinge caps and covers, opened by the dependent chains, to allow the escape of the air employed for the cooling down process from the interior of the oven to the external air. *k k* (figs. 2 and 4) are two openings with regulating valves, *l l* (fig. 4), through which, after the coal has been converted into coke, the cold air is introduced to the horizontal passages *m*, under and round the oven (but not communicating with the interior), for cooling down the coke: Those parts marked *n* between the brickwork forming the passages are filled in with concrete. The mode of operation is as follows:—The floor of the oven is covered with coal to the thickness of about two feet, the surface inclining a little from the front and sides towards the centre; the brickwork *b* to the oven mouth is built up as the coal is introduced, and the bricks luted with fine clay; a shovelful of burning coal is thrown in at top, and when the coal is fairly ignited the regulators of the door *c* are then closed; the apertures *d*, as well as the passages *f f*, are kept open until the coal is fairly ignited, and at the same time, the passages *k k* are kept entirely closed. At the conclusion of the process, the valves *l l* of the openings *k k* are opened, for admitting cold air to the chambers *m*, to cool down the coke, and at the same time the caps of the exit pipe *j j* are taken off. The coke is not to be removed from the oven until it has been thorougly cooled down.

Another part of the patent is for the application of electricity to purifying of coke from sulphur and other metallic mixtures, which is done in the following manner:—As soon as the flame on the surface of the ignited coal begins to die away, the apertures *s* of the door *c* and *f f* are closed; an iron rod is then introduced through the temporary brickwork of the mouth into the coke near the bottom, and passed through to the back of the oven to the flue *h*. A second rod is passed over the surface of the coke, so that it shall rest and be in contact with it. The former rod is connected with the positive pole of a powerful electric battery, and the second rod with the negative pole by means of copper wire, leaving the body of coke in the oven to complete the electric current. If the mass of coke be equal to six tons, it ought to be subject to the electric action for about two hours.

TANNING.

Robert Warrington, of Apothecaries' Hall, London, for "*Improvements in the operation of Tanning.*"—Granted March 25; Enrolled July 25, 1846.

This invention consists in the application of certain mixtures or compounds to be employed in the process of tanning hides or skins, the several mixtures being divided into three classes, which are as follows:—First, in order to prepare the skins for unhairing, the inventor proposes to employ carbonate of soda or potass, in the proportion of from one to two pounds to ten gallons of water. The second class is also intended to prepare the skins for unhairing and also to swell them, for which purpose the inventor employs various agents, such as baryta, potass, and soda, dilute muriatic, nitric, oxalic, or any other acid, except sulphuric acid. The third class consists of vegetable matters, such as rhubarb, sorrel, apple, mare, vine cuttings, and other similar vegetables, which may be economically employed. In the first class, from half-a-pound to two pounds may be added to ten gallons of water, the same being rendered caustic by the addition of fresh burnt lime; of the second class, the inventor prefers about the same proportions of muriatic acid, of specific gravity 1·17, to the same quantity of water; of the third class, the inventor prefers to employ culinary rhubarb. The following is a summary of the claim:—First, the application of carbonate of soda or potass when soaking the hides or skins, for facilitating the removal of the hair; second, the employment of baryta, soda, potass, and muriatic, nitric, oxalic, or any other acid, except sulphuric, together with the above named and other similar vegetable matters, for facilitating the removal of the hair and also swelling the hides or skins. He also claims the application of vegetable matters and chemical agents for retarding oxydation, which agents are to be used with the tanning liquor; and lastly, he claims the application of bi-carbonate of potass and dilute sulphuric acid for preserving the skins and other animal substances.

RAILWAY SAFETY BUFFER.

Edwin Chesshire, of Birmingham, for "*Improvements in apparatus to be applied to railway carriages to reduce the prejudicial effects of collision to passengers in railway carriages.*"—Granted February 3; Enrolled August 3, 1846.

The apparatus consists simply of a strong straight inflexible rod of either iron or wood, or both combined, placed longitudinally under the centre of the carriages; the ends of the rod are to have enlarged heads, and the length of the rod to be somewhat less than the carriage, to which it is attached, and the buffers when in ordinary contact. This rod, which the inventor calls a "safety buffer," is not intended to have any effect in stopping the motion of the train in the usual manner, but only when a violent collision, either before or behind, occurs,—then the heads of all the bars will be brought in contact, and "form one straight, inflexible, unyielding bar," by which means the effect of the collision will be neutralised.

ELECTRIC LAMP.

William Greener, of Birmingham, gunmaker, and W. E. State, of Peckham, Surrey, Esq., for "*Improved means of ignition and illumination.*"—Granted February 7; Enrolled August 7, 1846.

The invention is for the purpose of effecting illumination of public and private buildings, streets, &c., by means of solid or hollow prisms or cylinders of carbon (purified from impurities), or rods or strips of platinum, or other difficult fusible metal, enclosed in transparent air-tight vessels, and rendered luminous by passing currents of electricity; the carbon or metal is to be divided on the surface into numerous acute points. Hollow cylinders of carbon may be used, partially inserted within, and placed in perfect contact with, hollow cones of platinum, either plain or acuminated, and enclosed as before described.

CEMENT.

John Keating, of North Mews, Fitzroy-square, Middlesex, scagliolist, for "*Improvements in the manufacture of cement,*"—Granted February 11; Enrolled August 11, 1846.

This invention consists in mixing borax with gypsum (sulphate of lime) in the following proportions:—5 lb. of borax and 5 lb. of crude tartar are each to be dissolved in 6 gallons of water, and when dissolved the two solutions to be mixed together. Gypsum in lumps (first deprived of its water of crystallization by heat) is to be put in this solution till it has absorbed as much as it will take up, and then put in an oven and heated red hot; afterwards it is allowed to cool, and ground, and then again mixed with the above solutions and heated in an oven; when taken out, it will be ready for use.

LOCOMOTIVE ENGINES.

George Stephenson, of Tapton House, Chesterfield, engineer, and William Howe, of Newcastle-upon-Tyne, mechanic, for an "*Improvement in locomotive steam engines.*"—Granted February 11; Enrolled August 11, 1846.

The improvement consists in the application of three steam cylinders to locomotive engines, two to be of the same diameter and capacity, and together to be equal in capacity to one large cylinder. The pistons of all the three cylinders are to move simultaneously in the same direction; the large cylinder is to be placed exactly in the longitudinal central line of the engine, and the other two cylinders on each side at equal distances from it. The piston of the centre cylinder is to drive a crank on the axle of the impelling wheels, and the pistons of the two smaller cylinders are to be connected with crank pins fixed on the naves of the driving wheels; the crank to be fixed at right angles to the crank-pins. The intention of this arrangement is to neutralise any tendency that the oblique action of the connecting rods on their crank-pins may have to produce a lateral vibration on the supporting springs of a locomotive when travelling very rapidly.

RAILWAYS AND CARRIAGES.

Conrad Haverkam Greenhow, of North Shields, Esq., for "*Improvements in the construction of railways and railway carriages.*"—Granted January 6; Enrolled July 6, 1846. With Engravings, see Plate XIV.

The improvements relate, first, to forming the tyre of the wheels and rails so that they can be adjusted and adapted to each other. This is effected by using a convex rail and a peculiar formation of a concave wheel tyre, combined with inclined spokes, whereby, in the event of one rail sinking below the level of the other, the tyre of the sunken wheel will bear on the rail with an increased diameter, so as to compensate in surface motion for the depression; and from the peculiar concave shape, the wheel and the rail will maintain a correct adjustment in respect to each other. Notwithstanding any varying elevations and depressions of parts of the length of rails, the wheels on the opposite rails will at all times be running on such diameters as to make the distance moved through (by the common axle) the same, without any drag or friction corresponding with that heretofore consequent on the flanges, when moving against rails similarly circumstanced. And owing to this constant adjustment between the running surfaces of the wheels and the rails, the rails may be laid with the gauge so correct as not to allow of any play, for the adjustment which takes place will prevent, or tend to prevent, any rebound from rail to rail, besides there will be no tendency to run off the rail; and should there be any impediment to the wheels on one of the rails, those wheels may rise over such impediment without injury, owing to the opposite wheels retaining their correct contact with their rail, so long as the raised wheels do not rise off their rail to an extent which will throw the diagonal line on the opposite wheels beyond the perpendicular line.

Figs. 1 and 2 show the section of rails upon the improved form, which may be of wrought or cast iron. The inventor does not confine himself to the section shown, but the rail is such that the surface on which the wheels come is to be a portion of a cylinder, and part of the running surface of the wheels is to be struck to the same radius; hence, the two cylindrical surfaces will correspond. Fig. 3 shows a section of one of the wheels on an axle, and also one of the rails; the spokes are to be set at an angle of 22½°. Fig. 4 is an enlarged view of the rail and tyre.

The second improvement relates to suspending the body of the carriage *a*, as shown in figs. 5 & 6, on axes at each end at *b*, bearing on uprights *c*, fixed on the frame of the carriage *d*; the body is prevented oscillating by means of chains or straps *e*, which allow sufficient movement to the body as may be required. The frame *d* is fixed on the springs mounted on the lower frame *e*. The claim is for combining the suspension, as described, with the use of straps or chains.

The third improvement relates to applying "an uncontrolled locking action to the axles and wheels of railway carriages," as shown at fig. 7. *a* is a strong bar formed into the arc of a circle, sliding in bearings *b*, fixed on the frame; the bearings *c* of the axle of the wheels are made fast to this bar, and can only move within a short space, there being stops at *d d*. By this means, when a carriage is going round curves, the wheel accommodates itself to the curve.

REVIEWS.

Metropolitan Bridges and Westminster Improvements. By Sir Howard Douglas, M.P. Second edition. London: Boone, 1846. pp. 27.

The second edition of Sir Howard Douglas's pamphlet appears opportunely at a time when much public interest has been excited by the report of the dangerous condition of Westminster Bridge, and the proposal to replace it by a new structure. The old bridge was erected about one hundred years ago, and considering that it was built with scarcely sufficient strength to resist the comparatively gentle current of the Thames when its tidal waters were impeded by the huge piers of old London bridge, it would need no prophet to predict that the removal of those obstructions must ultimately involve the destruction of Westminster bridge also. The pamphlet before us describes the defects in the original construction, and the progress of the consequent injuries, but as these subjects are investigated with considerable minuteness in the official report now before the public, it is not necessary to enter into detail respecting them here. We shall prefer giving one or two extracts in which Sir H. Douglas describes his proposition for the improvements between Charing Cross and the river.

"All that can be expected from the expedients which have been tried is, that they may retard the ruin, which nothing, in fact, can avert—so that, with proper precautions, the bridge may serve as a temporary means of communication while a new one is being constructed; but even for this it would be prudent to lighten it as much as possible, by removing the masses of materials which form the foot-path on both sides, down to the level of the carriage-way, and to replace the stone balustrades, with a temporary railing or parapet of wood. Should the piles, which form the present caisson or cofferdam about the pier on the Surrey side, be not removed, they might be cut down; and if that or any other pier should seem to be in danger of settling further by the deepening of the water-ways, the expedient already proposed, of paving the bed of the river in those parts, or depositing there masses of stone, might be adopted as a temporary measure. It is somewhat remarkable, that, notwithstanding the defective mode of construction of Westminster bridge by caissons, and the large sums of public money laid out in vain attempts to rescue this bridge from destruction, it should be seriously proposed to adopt the like expedient on an immense scale in Dover Bay:—to strand caissons containing large portions of ready-made break-waters in 7 or 8 fathoms water for the formation there of a harbour of refuge! A new bridge cannot be constructed on the present site without previously removing the old one; and this would involve an expense of at least 40,000*l.* in erecting a temporary bridge, to avoid stopping altogether, the communication between the Borough and Westminster, whilst the new work is proceeding. There is no room for a new bridge between the Parliamentary Palace and the present bridge, for these are already in contact; and the construction of a bridge any where below the present site, say from Maudslay's premises to Manchester buildings, would occasion a very great outlay in providing new approaches. But, if leaving Westminster bridge, in its present state, as a temporary communication, a new bridge were constructed from Lambeth stairs to the nearest part of the opposite bank, no expense for new approaches would be incurred, a direct communication with Westminster would be established, and a magnificent entrance into the capital formed, at an interesting and venerable part. The river face of the new Parliamentary Palace, would be seen to great advantage; and, no longer disfigured and obscured on the other flank when the distasteful structure which now defaces it shall have been removed, the edifice standing gracefully and boldly out, would form a beautiful object upon the concave sinuosity of the river, extending thence to Blackfriars' bridge, and Somerset House, which, for this purpose, should be reclaimed from its present unwholesome and disgusting state by the proposed embankment and terrace, which it were easy to show is an interference with the state of the river much required at that part,—and thus that pestilential locality would be transformed altogether into a beautiful and highly embellished portion of the metropolis. From the Westminster end of this new Lambeth bridge, a street should be opened to lead directly to Shaftesbury terrace, Eaton and Belgrave squares, or to communicate with some part of that which is now being executed under the provisions of a late act, &c.; and another formed by the river bank, to Victoria Tower and Whitehall, passing between Westminster Abbey and the Parliamentary Palace. Entering the Court end of the town by this magnificent portal—St. Margaret's church removed, in conformity with the unanimous recommendation of a Select Committee, from the immediate vicinity of a splendid and ample place of worship, which requires not the aid of an adjoining church, and the relics which lie around that incongruous building, exhumed—the western face of the quadrangle, by which, according to the present design, it is intended to enclose Westminster Hall, set back, to give greater space between it and Henry the Seventh's Chapel;—Parliament street widened, by removing the block of buildings between it and King-street—Downing-street finished—and the Board of Trade completed, a majestic communication would be formed, between the Regal and Parliamentary Palaces; and if Whitehall-street may not, or cannot be straightened throughout, those buildings at least should be thrown back, which, on approaching Trafalgar-square, obtrude, more immediately on the left, to destroy its symmetry."

The last sentence of this extract pleases us but little. We would much rather see St. Margaret's Church restored than destroyed. It was once one of the most magnificent churches in London, as those who have seen the old prints of it can testify; the work of desecration has, it is true, proceeded very far, but not beyond remedy; and in the hands of a judicious architect St. Margaret's Church might once again raise its head unmarred by the vile barbarisms of the last age. The desire of removing this structure for the purpose of obtaining a clear and uninterrupted view of Westminster Abbey, proceeds from ignorance of the true principles of Pointed Architecture, which always appears most beautiful when it affords picturesque combinations of numerous detached parts. We accordingly see that the mediæval architects loved to group a great many different structures together, and adjacent to a cathedral usually erected its cloister, chapter house, baptistery or collegiate buildings. It is precisely this combination of a crowd of pinnacles and towers, steep roofs and massive buttresses, from which arises the magnificence of a pile of Pointed buildings: and for this reason also (though there are many others) the demolition of an ancient church in the neighbourhood of a cathedral can never be justified except on the plea of unavoidable necessity. St. Margaret's is at present covered over with a thick coating of plaster, the tracery of the windows has been destroyed, the panel-work of the tower concealed by stucco, the finials and crockets churchwardenised; but great as are these injuries, they are not past all surgery, and we unhesitating repeat that a judicious restorer of this ancient church would have the honor of adding one more to the number of beautiful buildings with which this interesting spot is crowded.

For the same reason that we would retain St. Margarets' Church we would resist any project for erecting a continuous pile of buildings concealing Westminster Hall. The irregular outline of the Palace of Westminster on the Abbey side is far more in accordance with the spirit of Pointed architecture than the flat unbroken surface of the river front. It is most desirable that the present pseudo-classic law courts should be removed, and that the magnificent flying buttresses on either side of Westminster Hall should be displayed; but the proposition for enclosing it altogether is unjustifiable. Neither do we see the necessity of throwing down the buildings which "on approaching Trafalgar-square obtrude more immediately on the left to destroy its symmetry." We quite concur with the general opinion that for the sake of the national character for good taste, Trafalgar-square ought to be kept out of sight as much as possible.

To turn to a different subject, we must notice what seems an error of principle in a note (p. 7—14), the object of which is to prove that Hungerford bridge is not built with sufficient strength. It is first shown that the utmost load which can by any chance be put on the bridge at one time is less than one-third of the weight which would impair the chains. This excess of strength is pronounced insufficient; but the opinion is not confirmed by very conclusive reasoning: among other things the curve of the chains is assumed to be a common catenary, which it is not. The note then proceeds

"There is one additional point still to be noticed, namely, the pressures on the piers. It is shown by writers on mechanics, that the horizontal strain at every point of the chain is the same, and equal to the tension at the lowest point of the curve. When a bridge is properly constructed, the catenary on the other side of the pier is a portion of the same curve as the first. The horizontal strains on the two sides of the pier will then be equal, but in opposite directions, and, therefore, they will counteract each other: the two vertical strains will also be equal, and in the same direction: and as it is evident that each of those strains is equal to half the weight of the chain between the piers, the vertical pressure on each pier is equal to the weight of this chain. (See *Military Bridges*, p. 311). In the case of the Hungerford Bridge, however, the catenaries at the two ends when completed, have a considerably less span than the central curve, but they have the same droop or deflection. Hence if $2y$ be the span of the centre arc, $2y'$ the span of the curves at the two extremities when completed; and a, a', the corresponding tensions at the lowest points, we have

$$a = \frac{3y^2 + x^2}{6x} \qquad a' = \frac{3y'^2 + x^2}{6x}.$$

And as y' is considerably less than y, a' will evidently be less than a in a still higher ratio. Hence there will be a constant horizontal strain, equal to $(a - a')$ acting at the top of each pier, (which the ingenious contrivance of the shifting saddles at the summits of the piers cannot remedy,) which will of course tend to pull and shake the piers, and may ultimately overthrow them, founded as they are, without underpiling, on the natural bed of a river, which is continually becoming deeper."

The conclusion here arrived at is erroneous, and the error arises from the application of a formula to a case with which it has no connection. The value given for a' is taken from the expression for the tension in a chain at its lowest point, when the chain is suspended between two piers of the same weight, and *the lowest point is consequently horizontal.* But here the shorter chain at the end where it is attached to the abutment on the banks of the river is inclined to the horizontal at a considerable angle. Moreover if the saddle (which is furnished with friction rollers) were acted upon by an accelerating force $a - a'$, it would be set in motion. And lastly, however, the question may be complicated by mathematical symbols, the general truth remains indisputable, that the pressure of the rollers upon the top of the pier is normal to the surfaces in contact, and is therefore wholly vertical. Consequently the reader, whether acquainted or unacquainted with mathematics, will not have much difficulty in concluding that the danger of the piers of Hungerford Bridge being overthrown by the unequal strain of the suspension chains is purely imaginary.

A Critical Dissertation on Professor WILLIS'S *Architectural History of Canterbury Cathedral.* By CHARLES SANDYS. Smith, Old Compton-street. 1846. pp. 62.

Canterbury Cathedral is in one respect pre-eminent beyond dispute above all other ecclesiastical edifices in England; more has been written about it than about any other. Not only is its library rich in manuscript chronicles and records of the erection of different parts of the building written contemporarily by resident Monks, but the number of Itineraries, County Histories, &c., of comparatively recent date, in which this cathedral is described as unequalled with respect to similar buildings.

The work of description seems to have gone on nearly continuously from the time of the Conqueror to the current year 1846, and probably is not yet finished: for the dissertation by Mr. Sandys, is of too controversial a nature to remain long without an answer. We have no intention of plunging ourselves or readers into the labyrinth of a purely antiquarian discussion; still as the name of Professor Willis of itself carries considerable interest with it, and as his opponent has displayed great learning and accumen in conducting the controversy, a good many architectural readers will be anxious to know what the dispute is about.

Simply this: Professor Willis ascribes the architecture of a large part of the Cathedral to an architect who, Mr. Sandys says, has no claim to the merit. There is something very laudable in this anxiety to commemorate not only the building but the name of the builder, which might be imitated with advantage in more modern instances: still we apprehend that the question whether Archbishop Anselme built merely the choir of the present cathedral, or the external walls of the choir-aisles, the Trinity chapel, and the east transept also, will not attract so large a share of public attention as to render it incumbent upon us to give more than a brief outline of the discussion.

The dispute seems of long standing. We have before us an old and we believe rather scarce copy of Somner's Antiquities of Canterbury,* published in 1640 (the *imprimatur* is dated from Lambeth, October 1639.) Now Somner alludes to the subject of this very dispute—namely, what parts of the cathedral are to be assigned to Anselme and Ernulph—in the following terms.

"*Matthew Paris* Records a dedication of the Church of *Canterbury* in the yeare of Christ 1114. being the yeare of Anselmes death. Haply it was of that new piece or new work, as Edmerus cals it. This doubtlesse is the part meant by *Malmesbury*, ascribed to *Ernulphus* the then Prior of the Church, and of him (erroniously it seemes) said to have beene built in the place of a like part then demolished, whereof he hath these words *Cantiæ* (saith he) *dejectum priorem partem ecclesiæ quam Lanfrancus ædificaverat, adeo splendide erexit, ut nihil tale possit in Anglia videri, in vitrearum fenestraum luce, in marmorei pavimenti nitore, in diversicoloribus picturis quæ mirantes oculos trahunt ad fastigia lacunaris.*"

The above extract proves at least thus much, that there has long been a dispute respecting the architects of the eastern part of the church. Mr. Sandys has not referred to this circumstance; he gives however the Latin sentence from Malmesbury, with his own translation, which commences "Ernulphus having thrown down the *front* (or fore part) of the church which, &c." It may be observed that the assumption that Ernulph was the author of the work of demolition is Mr. Sandys's own. The original Latin simply states that part of the church was thrown down—but does not inform us whether destruction was accidental or intentional, or who was the destroyer. The whole dispute turns on the interpretation of the words "priorem partem," which Mr. Sandys takes to mean the choir and no more; whereas Mr. Willis gives the phrase a much wider signification. The former takes it to mean the choir, the latter the whole eastern part of the church. Might we not translate *priorem* simply "former" or "older"? In that case the meaning of the quotation would be that "Ernulph rebuilt an older part originally erected by Lanfranc, which had been thrown down."

The author in the present dissertation gives several extracts from Edmer, &c., in confirmation of his opinion, but his translations are in one or two cases made more favourable than they ought to be, for his own side of the question. For instance, "*super hæc, ipsum oratorium quantum a majore turri in orientem porrectum est, ipso Patre Anselmo providente disponente, auctum est.*" he translates thus, "Moreover this oratory [choir or chancel] so far as it stretches from the great tower eastward was enlarged, Anselm himself providing for and directing the works." The words *super hæc* are not represented with sufficient force in the translation. *In addition to these things* Anselm enlarged the oratory *itself*—meaning that he had undertaken other works besides that. This interpretation, if it do not specifically assign to Anselm the works which Professor Willis assigns to him, at all events leaves room to suppose that he did more than Mr. Sandys would have us believe. He neglects also the word *ipsum* which adds force to the *super hæc*: and his assumption that *oratorium* means the chancel or choir is at least controvertible. An oratory is a place of prayer in distinction to auditorium, the place for hearing. We may therefore suppose every part of the church set apart for prayer, to be included in the word *oratorium*. Mr. Sandys quotes the expression *finis ecclesiæ ornabatur oratorio beatæ Matris Dei Mariæ*, and this instead of confirming his interpretation seems to show that there were all over the church parts distinguished by the appellation *oratorium*, which therefore is not limited to the choir. The sense of the passage seems therefore—that in addition to other works Anselm's labours extended to that part of the church which is devoted to prayer, and that he enlarged so much of it as was built to the east of the great tower (intimating, it may be surmised, that there were parts to the west also set apart for prayer.)

Mr. Sandys states, page 43, as a conclusive objection to Professor Willis's opinion, respecting the architect of the present Trinity Chapel, that Lanfranc is expressly stated in the Latin history to have been buried in Trinity Chapel, which must therefore have been standing at the time of his death. But this difficulty is entirely got over if we suppose Trinity Chapel to have been one of those parts of Lanfranc's works which were subsequently destroyed and then rebuilt by his successors.

In an architectural point of view it seems difficult to suppose that Anselm could have enlarged the choir without rebuilding the choir aisles and their external walls. There seems nothing unreasonable in Professor Willis's supposition that "the increased space must have affected all the arrangements of the choir of the monks."

We throw out these suggestions merely to show that Mr. Sandys arguments are not of such a nature as to preclude reply. We are tolerably well acquainted with the architecture and history of Canterbury Cathedral, and

* Mr. Sandys quotes from the same book, but from a much later edition: the original work is the more interesting because written before the commencement of the Civil wars, in which the Cathedral greatly suffered.

ave examined the choir with Mr. Sandys's book in our hand, but confess ourselves unable to form a decisive opinion on this question. There is no doubt that Professor Willis's reply will clear up many apparent difficulties: at the same time Mr. Sandys has the merit of arguing his case acutely, and of duly acknowledging the learning and research evinced by his opponent. The following extract from the publication before us is selected rather as a specimen of the general style than as referring to the particular question above alluded to—there is little in it which will gratify the lovers of mongrel architecture.

"*The Dark Ages (16th to 19th Century.)*—England at the commencement of the sixteenth century possessed in its cathedral and parochial churches, abbeys, priories, and other monastic and conventual structures, the most splendid specimens of the Saxon, Norman, early English, decorated, and perpendicular styles of architecture; whilst Henry VII, in his newly erected chapels at Westminster and Cambridge, had carried the florid Tudor style to the utmost perfection. These temples were, however, the abodes of the most abject and degrading superstition, of the most revolting and disgusting idolatry. Hence arose the fierce and bitter contest between truth and error, between the pure and undefiled religion of the gospel, and the legends, lying miracles, and extravagant pretensions of the See of Rome. This struggle terminated in the Reformation. Glorious as was the emancipation of the human mind from the degrading influences of superstition and Papal tyranny, yet we cannot but deplore the iconoclastic zeal of the reformers and puritans, which, not satisfied with removing the idolatrous shrines, altars, and chantries, violated the sacred repositories of the dead, destroyed the tombs and sepulchral monuments which pity had raised to the memory of departed worth, and levelled to the dust some of the most beautiful remains of the architectural skill of our forefathers. Then also arose the Royal Ruffian, at whose name humanity shudders, and religion herself grows pale! This ruthless tyrant having dissolved the monasteries, extorted from his parliament a grant of the possessions which were annexed to them, a large portion of which he afterwards parcelled out amongst his courtiers and flatterers. This led to the rapid decline, and at length, total extinction of English ecclesiastical architecture, and the revival of the classical style, (shortly afterwards introduced from Italy,) completed the downfall of a science which had for many centuries been the pride and glory of our country. In these more enlightened days we are astonished that men of the greatest genius should so long have continued blind and insensible to the sublime beauties of our native architecture. But to show their utter ignorance and contempt, they have even branded it with the approbrious name of 'gothic.' Inigo Jones (the English Palladio) with most inharmonious taste, added a *Corinthian portico* to the west front of the venerable gothic cathedral of St. Paul, London; and Sir Christopher Wren (struck with its want of harmony) afterwards wished to replace the whole of the gothic church by another to accord in style with Inigo Jones's classical portico. This scheme, though opposed at the time, was afterwards rendered inevitable by the great fire of London, which involved both the gothic cathedral and its classical portico in one common ruin. So great indeed was the darkness of this period, that even Addison's cultivated and enlightened mind could not appreciate the exquisite beauties of Gothic architecture. It is at once amusing and instructive to hear his remarks. .... If to the illustrious names of Inigo Jones, Wren, and Addison, we add those of Somner, Battely, and Gostling, (the learned historians of Canterbury Cathedral), no admirer of that venerable and exquisitely beautiful church will censure us for appropriating to the last three centuries the opprobrious appellation of 'the Dark Ages.'"

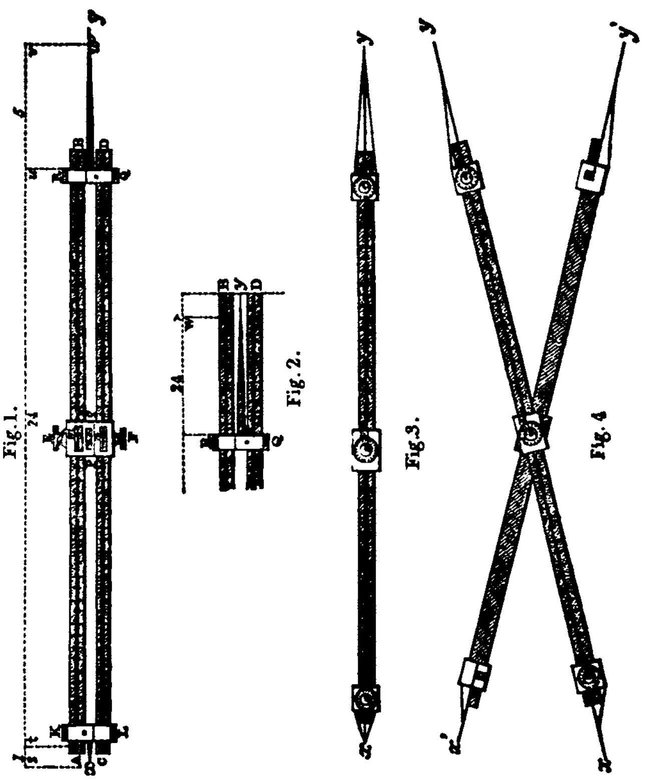
Our author might have added that the ignorance of the true principles of architecture extended to the Classic as well as the mediæval styles. It is not so many years since a great architectural authority expressed his opinion that the Parthenon would be improved if surmounted by a steeple!

Mr. Sandys scolds Professor Willis for not describing the restorations which the present Dean and Chapter have effected in the cathedral, under the supervision of Mr. Austin, their architect. Why did not Mr. Sandys supply the omission? He is an inhabitant of Canterbury, and probably has had ample means for fulfilling the task.

Description and uses of the Byrnegraph, or new proportional compasses, an instrument for multiplying, dividing, and comparing lines, angles, surfaces, and solids: by Oliver Byrne, formerly Professor of Mathematics, College for Civil Engineers. Adlard, 1846; pp. 38.

The purposes of this publication are the explanation and illustration of the uses of an instrument invented by Mr. Byrne, to which the British Association has given the not very descriptive appellation of the "Byrnegraph." The object of this invention is to attain increased accuracy in the use of proportional compasses, or rather, to so extend the use of them, that the improved instrument bears to its prototype much the same relation as a Manton to a matchlock.

With the old proportional compasses, lines could not be reduced with even tolerable accuracy to less than one-ninth their original size; but, by combining with them the vernier scale, the new instrument not only effects much greater reductions with perfect accuracy, but may be made to indicate proportions which extend to several places of decimals. For instance, at page 26 is explained how the compasses may be set to the proportion 1 : 3·1416, the ratio of the diameter of a circle to its circumference. These refined adjustments are perfectly unattainable with the old instrument. Fig. 1 is a side view of Mr. Byrne's invention, of which fig. 3 represents the plan when the instrument is open; fig. 4, when it is shut. Fig. 2 is a separate view of one end of the compass.



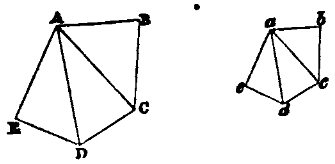
The principal feature of the invention is that the moveable centre E F, about which the two arms turn, is provided with a vernier, and that the points x, y, are moveable and also provided with verniers. Beside this, there are tightening screws to fix all the points when they have been adjusted.

"The framework of this instument may be made to assume different proportions and forms for the sake of ornament, compactness, or convenience, according to the fancy or design of the maker; the first completed was constructed by Cary, 181, Strand, London, and explained at York, before the British Association, in 1844. A view of the instrument, which we shall describe, is given (fig. 1); it differs but little from that constructed, according to the directions of the inventor, by Désiré Lebrun, of Paris. The two boxes E p q, F p q, are so adapted to the beams AB, CD, that they may be moved together by sliding to any part and fixed in that position by tightening the clamp screws E and F. When the moveable centre E p q F, is clamped in any position, the instrument turns on an imaginary line or axis passing through EF, perpendicular to a plane passing through P q, the junction of the boxes E p q, F p q, the friction of the planes meeting at pq renders the motion uniform. Connected with the brass boxes at K and L are two points of the instrument meeting at x: at K and L there are two clamp screws to fix the boxes, which must be moved together. When the points are in their proper places, the proportions of the instrument that we are describing are these:—Suppose $st=1$, then $tu=24$, and $uv=5$. The points at x are represented in proper adjustment, but those at y must be moved till y comes up the line v w, and then made fast by the clamp screws at Q and R."

The faces of the arms are graduated to four scales, which mark the proportions for straight lines, circumferences of circles, surfaces, and solids, respectively. Tables of the numbers corresponding to these graduations are given in the publication before us, and as instances of the application of them, we quote the following problems, taken at random:—

"In the circumference of a circle A B B′ it is required to lay off an arc equal to 3° 39′ 37″·26."—Page 20.

"Let it be required to describe a figure *abcde*, similar to A B C D E, whose area will be $\frac{1}{17}$ of it."—Page 21.



"Let it be required to construct a parallelogram whose area shall be equal to that of a given circle."—Page 26.

"Describe a circle whose circumference will be 11¾ inches."—Page 27.

"Given the diameter of a globe, to find the side of a cube whose solidity will be equal to that of the globe."—Page 28.

"In a certain construction the square root of 33 equal parts is required with great accuracy; at what point must the centre be set to effect this object?"—Page 28.

Mr. Byrne has not spared his labours. The tables which he has given for the purpose of graduating the instrument are very extensive and carried to a greater number of places of decimals than would be generally required in practice. The explanations are so ample and precise that, with this book before him, the draughtsman can never be at a loss respecting the various problems which he is constantly called upon to solve by practical construction. It has been remarked truly that, while the theodolite, sextant, and other instruments of surveying, have been brought to extraordinary perfection by the refinements of modern ingenuity and workmanship, the constructions obtained from these exact instruments are reduced in a very rude manner. While almost everthing that could be done for attaining accuracy in the original trigonometrical operations has been effected, the means by which they are rendered practically available have been comparatively disregarded until the invention of the simple instrument which we have been describing.

Proposal for a general Metropolitan Railway. By J. C. H. Ogier, Esq., Barrister-at-Law. London: Weale, 1846. pp. 14.

This pamphlet is published in the form of a letter addressed to the Commissioners for inquiring into the various railway projects of which the termini are proposed to be established in or near the metropolis; the object of the letter is the discussion of a plan for uniting the various metropolitan railways in such a manner that they may be rendered accessible from every part of London. The impartial opinion of an unprejudiced person, on a subject usually debated with reference to individual interests, is generally worth having: and accordingly in this pamphlet we find the various schemes for perfecting the railway communication with London put in a new light, because for the first time examined by one who has no private interest in the settlement of the question. Mr. Ogier observes truly that with respect to the project for uniting the various great lines which now radiate from London, "the greatest impediments arise from the clashing of the various interests connected with it, rather than from the impracticable nature of the undertaking."

The proposal that a line of railway should be laid down according to a scheme agreed upon by representatives of the interests of each railway company, the city corporation, and the government, appears very practicable, and moreover it is suggested by the wise policy which avoid obstacles instead of overcoming them. There is no doubt that by a little tact all the companies might be enabled to come to an agreement respecting the method of connecting their lines, and the course so agreed would probably be the best that could be devised. In all other great cities but London the traveller is able to pass from one line of railway to another without incurring the wearisome and unnecessary delay of traversing the extreme length of the city through crowded streets; whereas facility of uninterrupted communication with opposite parts of the kingdom is the most important with respect to London, where the traveller is frequently delayed as many hours as would suffice for the rest of the journey. The object is one of national interest, and impartial practical suggestions such as those here offered towards the effecting so important an undertaking, deserve the attention of all who would have the subject fairly discussed.

A Series of Letters on the Improved Mode of the Cultivation and Management of Flax. By James H. Dickson. London: Groombridge, 1846. pp. 248.

This book deserves attention, as the result of the observations of one who has devoted fifteen years assiduously to the examination of the subject. We confess ourselves incompetent to give an opinion as to the merits of the several improvements suggested by Mr. Dickson; still we imagine that his object will be sufficiently answered if we draw the attention of those interested in the cultivation of flax to the fact that they will here find detailed information on every point connected with its agricultural and commercial purposes. The machinery for spinning the yarn, &c., the economic value of the plant, ascertained by a comparison of the cost of cultivating it, and its productiveness, and the methods of cultivation and preparation for manufacture pursued in various countries, are fully and clearly described.

Gothic Ornaments, being a Series of Examples of Enriched Details and Accessories of the Architecture of Great Britain, drawn from existing authorities. By James K. Colling, Architect. Bell, Fleet-street, 1846. Nos. 1 & 2.

Every contribution towards a more accurate knowledge of the beautiful architecture of our ancestors is worthy of commendation; and the work before us is one of the most elaborate which has been published with this object. Each part contains one illuminated, and three uncoloured, lithographic plates. The subjects are the decorative enrichments of Pointed structures, and will comprise "bosses, canopies, capitals, crockets, corbels, dripstone terminations, finials, foliated cusps, gurgoyles, pateræ, poppy-heads, spandrils, subsellœ, string-courses." The subjects of the first illuminated plate are portions of a Perpendicular rood-screen in Langham Church, Norfolk, showing the manner in which it is enriched by painting. The colours are magnificent, and beautifully printed. The other plates contain poppy-heads from Paston Church, Norfolk, wooden spandrils from North Walsham Church, and capitals from the choir of Ely Cathedral. The subject of the illuminated plate in the second part is diaper enamelled on copper gilt, from the tomb of William de Valence, in St. Edmund's Chapel, Westminster Abbey. The other subjects are details from Lincoln and Norwich Cathedrals.

We certainly object to the use of the word "Gothic" as applied to forms so beautiful as those here depicted, but it is difficult to find a substitute for it. We are not favourable to the unnecessary invention of technicalities, but certainly wish the continental term "Ogival" were in more general use in this country; the word is expressive and does not involve an architectural or chronological blunder. The ornaments delineated by Mr. Colling are Ogival—not Gothic. We must not conclude without speaking in commendation of Mr. Jobbins, for the very beautiful manner he has got up the illustrations.

Tables for setting out Curves for Railways, &c. By G. C. Darbyshire, land-surveyor. Weale, 1846. pp. 16; foolscap.

The review of a series of tables can contain little more than an opinion respecting the general method of calculation; an examination of the accuracy of the numerical results cannot be expected. As far, then, as concerns the general method, this little work has our unqualified approbation: there are many grounds of superiority to similar publications; in the first place, instead of mere rules for calculation, which, in practice, would be found tedious and liable to error, the actual figures are here given, and can be referred to at once; in the second place, the curve for which the calculations are made is the arc of a circle, and not a parabola; lastly, alternative methods of calculations are employed, so that where the nature of the ground does not admit one set of tables being used, another may be substituted. The following is the author's preface, which, being brief enough, may be given entire:—

"The author calculated the following tables for his own private use, but at the solicitation of several friends, he has been induced to publish them. He can speak with confidence of their accuracy, great pains having been taken to prove every figure, and the utmost caution observed in correcting the press. When the calculation of these tables was nearly completed, the author's attention was directed to the 'Civil Engineer and Architect's Journal' for January, 1840, containing tables (calculated by Mr. A. A. Mornay) on the same principle, but having only the column headed t for finding the tangent to the curve: and it was satisfactory to find that the principle he had adopted had been approved of by the conductors of that Journal."

A table showing the Contents of Excavations, derived from Mr. G. P. Bidder's formulæ. By C. Creedy. Maynard, Earls Court, 1846. 24 mo. pp. 24.

This is a pocket edition of Mr. Bidder's tables, of which the utility has been greatly increased by Mr. Creedy's additional calculations for much greater depths than those for which the original tables were formed. Mr. Bidder's formula appears quite correct, but has this defect—that the application of it is limited to those cases in which the cross section of the surface of the ground is horizontal. For the admeasurement for side-long ground and excavations of which the vertical depths depend on the inclination of the natural surface of the ground, we must refer the reader to the more comprehensive tables by Mr. Hughes. (See *ante* p. 73.)

COMPETITION DESIGNS.

Sir—It is time for those who regard either the interests or the credit of the architectural profession, to protest in the most unqualified manner against a most scandalous practice that has of late come up, and which if not openly reprobated and stigmatized will become confirmed. The practice I allude to is that of obtaining designs for a mere nominal price, by means of a very plausible artifice, yet at the same time so very transparent that it might be thought no one could possibly be gulled by it; nevertheless that it does succeed is but too certain, since otherwise it would not be continued. Either a builder himself or those who intend to employ one without calling in an architect, wants a design, and accordingly resort to the following clever expedient of getting one as cheaply as possible. They know very well that they cannot apply to an architect only to make them drawings for the purpose without paying him a fair equivalent for his time and trouble. Even their own sense of common decency deters them from going to Mr. A. or Mr. Z., and saying: we do not intend to employ you as our architect, all we require is a set of drawings, and if you will prepare one for us, for Five Pounds or so, you are our man. They have an instinctive suspicion that such an offer would be received not as a kindness, but a personal insult. What therefore they dare not propose to an individual, they do to the profession generally. The additional cost of the advertisement, will they know—at least hope—procure for them, not only one design, but many, from which they can choose. Accordingly the advertisement is *fairly* drawn up, and it very *honestly* stated in it, that the architect whose design is approved will *not* be employed, but that he will be entitled to a SMALL PREMIUM!—so very small it seems that it is not at all adviseable to give it its money name, lest it should operate as a scare-crow instead of a bait. Nevertheless, small as it is, the premium is not to be flung away, but is to purchase for the liberal advertisers the possession of the *fortunate* drawings!

After all, too, what assurance is there that there may not be some dirty trickery at the bottom of this apparent fairness,—though at the best very evident paltriness?—What assurance that the premium is paid to any one? If when the designs are looked at, it is found that there is no occasion to retain any one of them, for expressly making use of it, all that each competitor knows is that he gets back his own, and that he is not the *fortunate* man. After that, nothing further is heard of the matter, till, perhaps some local newspaper informs its readers that: "the new ——— is just completed, and cannot fail to obtain for their talented townsman, Mr. ———, the title of the *Fudgeall* Vitruvius; it is particularly chaste, the windows being quite unencumbered by any mouldings," and so forth.

What is the Institute about—what the profession, and also you Editors, that one and all suffer such iniquitous and shameful transactions to pass unrebuked, instead of exposing them, and branding and cauterizing those who are implicated in them? How much longer do you mean to tolerate such skulking hole-and-corner proceedings,—such a species of systematic swindling—for in reality it is no better, though not of that kind which the law can take notice as *illegal?* But if not illegal it is base and scoundrelry, and if nothing else can be done to check it, it is probable that insulting advertisements would not be hazarded, were public indignation to be most strongly and unequivocally expressed against them. Or are the whole profession so white-livered and pluckless to a man,—each one so entirely for himself alone, that none care for aught beyond self—beyond what concerns self directly and immediately, that they can put up with such abuses without the slightest effort to repress them? The question will be answered one way if not another; for should the matter be let drop, that of itself alone will confirm the opinion of

VINDEX.

THE CATHEDRAL OF COLOGNE.

The following extract from the *Athenæum* will be read with interest, and the concluding suggestion especially is worthy of attention:—

"Before the Germans, incited by the example of the King of Prussia, began to take up the matter so warmly as they have lately done, one of your correspondents wrote with animation and interest on the subject of the works executing at the Cathedral of Cologne—undertaken to redeem what poor Hood so poetically called a "broken promise to God." The nine years which have since elapsed have done wonders; opened many a journal besides yours to the subject,—enlarged progressively the interest of Europe in an undertaking, the accomplishment of which need no longer be considered a chimera,—and added largely to the funds provided. The Colognese gentlemen and Herr Zwirner, the gifted and indefatigable architect, now say with confidence that, in twenty-five years the *Dom* may be completed, even to the spires;—and this, not in bravado, but from calculation, based upon present progress. To the tourist, approaching the building at railway speed, who sees, as yet, no appreciable diminution in the enormous gap betwixt the choir and the crane on the western tower—such promise seems an extravagance; but they who have had the privilege of looking into the details, in company with the architect, may admit the possibility of the feat.

"In two years, as Herr Zwirner *showed* us, the nave, aisles, and transepts of the Cathedral may be thrown open—not, in truth, to the entire height; but complete to a level above the clerestory windows. The vaulting of the side-aisles will be then completed; and a temporary roof will be easily placed over the central portion,—leaving, within, the upper part of the walls, vaults, &c., to be raised:—without, the flying buttresses, pinnacles, and other garnitures, are a more serious business. The raising of the transept walls to their present important height, Herr Zwirner assured us, was a heavier two years' task than what remains to be done in realization of a scheme so attractive to the fancy. Moreover, the casual visitor is little aware of the vast collection of ornamental sculptures, ready to be placed, which the workshops contain. The canopies round the retreating portal of the northern transept are already fixed: the capitals of the pillars of the clerestory gallery are waiting, by the score. Let not my statement mislead any one into imagining a case of *manufacture*. The old capricious variety of fancies in ornament has been as religiously carried out as every other intimation of the nameless architect's intention. The small grotesque figures at the angles of the canopies aforesaid (which are merely shelters for statues of saints, angles, &c.) are as minutely finished and whimsically diversified as if they could be seen without the aid of an opera-glass when they shall be raised to their destined position. The foliage, again, of the capitals has the sharpness of the best period of cutting. No two devices are alike. The stone used for these more delicate portions is of peculiarly fine and close quality, from Rochefort. Nothing seems slighted or overlooked; and the workmen, of course, become more skilful as they proceed, and fuller of spirit and invention. A growing confidence that all this labour is not to be in vain as regards the grand result, probably animates those who have contributed to a scheme so magnificent, but for a long time deemed so visionary. Windows are beginning to drop in. The King of Bavaria's donation of *six* for one of the side aisles will be ready in 1848; and then, it is said, the spell is to be broken—the wall thrown down betwixt nave and choir, with splendid festive ceremonies. This will give an immense impetus to popular feeling. I was shown the corner where our Queen's donation is to be placed. When I saw this, and was told of one window contributed by Herr —— at a cost of thirty *Friedrichs d'or,* and of another promised by some other enthusiast—a wish arose in my mind, to which you will, perhaps, not object to give currency. Would it not be a pleasant thing to the English artists and lovers of art to have *their* memorial in such a building? One of the smaller windows—presuming their zeal unequal to vie with that of Royal donors—might be handsomely compassed for fifty sovereigns: or, let us say—to state the sacrifice more tangibly to those whom I fain would interest—fifty white-bait dinners! Could not so much as this be done, without injustice to any of our own works of art or benificence? It is true that the offering, when completed, would make little more show than the hatchments or votive tokens which cover the walls and pillars of the Catholic churches abroad; but it would be, still, "the Englishmen's window," for the father to show his son—a token of brotherly kindness and sympathy, especially grateful to such lovers of memorials and celebrations as are our German friends;—who, let me add, are more abundantly irritated by the sneers and exactions of our swarm of vulgar summer tourists, than soothed by the courtesies of the refined and intellectual among us. At all events, my hint can do no one harm."

To the above, the following particulars, taken from the report of Zwirner the architect, may be added. The past winter was chiefly occupied in preparing the stones required for the triforium of the nave and the north and south transepts. On examining the foundations of the great north tower, they were found to be so imperfect that it will be necessary to excavate to the depth of thirty feet in order to renew them. This discovery will lead to great delay and labour. Zwirner complains that the employment of workmen on five different portions of the building simultaneously leads to needless trouble and expense. The list of royal donations is as follows:—Emperor of Austria, £833; King of the Netherlands, £84; Grand Duke of Baden, £170; King of Hanover, £86; Prince of Lichtenstein, £96; Queen Victoria, £525. The most favourable signs of progress are the arching of the south aisles and the completion of the north and south portals. The latter are already arched over. Considerable controversy has existed respecting the manner of erecting the south portal; certain traces of foundations which have been discovered, and which are said to indicate the form which this part of the cathedral was intended to assume, have been disregarded in the restoration. The restorers appear, however, to have acted on mature deliberation, and the restoration of the north portal, which is indisputably in accordance with the original plan, furnishes a powerful answer to the objections raised respecting the south portal.

NOTES OF THE MONTH.

The Tubular Bridge.—It appears from the report of the engineer of the Chester and Holyhead railway, that the model tube constructed by Mr. Fairbairn, one sixth of the actual size, has been subjected to such experiments as he considers sufficiently justify the company proceeding with the works. He reports:—"In the former preliminary experiments, I was led to the conclusion that great care would be required to prevent the upper side of the tube from crushing,—that, in short, the main object to be aimed at was to give the top of the tube the requisite stiffness. In this respect, the result obtained from the model has been highly satisfactory; and, being upon so large a scale, may be deemed perfectly conclusive upon several important points. The dimensions of the tube were as follows: length, 75 ft. between the supporters; depth, 4 ft. 6 in.; width, 2 ft. 6 in. The total weight a little above five tons. When progressively loaded, the mean deflection was about one-tenth of an inch per ton; and with a load of thirty-five tons suspended in the middle, it gave way on the under side,—the upper part not having exhibited the least sign of failure up to the moment of fracture. Hence, therefore, we have arrived at a most interesting result; viz., that the liability of the plates on the upper side to crush has been completely removed from the construction in compartments. The experiments having now furnished us with the necessary means of calculating the relative thickness and proportions of the several parts of the tube, we are in a condition to contract at once for their construction." Supposing the strength proportional to the size, the real bridge ought to break with six times the load on the model—that is, with 210 tons, and the deflection would be 21 inches. Mr. Stephenson stated, in his report, that 747 tons on the centre, or double this distributed over the whole bridge, though equal to any weight "that can in practice be placed on the bridge, is not sufficiently in excess for practical purposes." But the supposition which seems to have been acted upon in this experiment that the strength is directly proportional to the dimensions, is founded on false philosophy. The load which can be sustained is a function not of the length, but of the *square of the length* nearly; or at all events, depends on a higher exponent than the first power of that quantity. The deflection would depend not on the breadth and depth simply, but probably on the *cubes* of those quantities.

Buckingham Palace is to be enlarged by the addition of a fourth side, completing the quadrangle: the architect is Mr. Blore. Let us hope that the faults in the present structure will not be repeated—that columns will be used to support the building—not to be supported by it, and that there will be no sham pediments stuck on for show. The destruction of the huge triumphal arch, supporting nothing but a little flag-staff ("a most lame and impotent conclusion"), is happily resolved upon. The proposition to build an altogether new palace of purer architecture seems preferable to that of patching up the old one. The liberality of the people of England must, in the former case, be the more acceptable to the Queen, because forced upon her, as it were, in generous disobedience to her expressed wishes.

Triumphal Arch, Piccadilly.—The statue of the Duke is to be hoisted up after all, and to remain on the arch for three weeks, *to see how it will look.* Sir F. Trench might as well walk through London on stilts, to see how *he* would look. This scheme of putting up the statue on trial appears very much like a *ruse*: the pieces of metal, if soldered together, cannot be disunited without injury. Besides, it would be much easier and cheaper to again raise the great wooden doll which was placed in the same situation as a gazing-stock some time ago.

At the anniversary meeting of the Botanical Society of London the receipts were stated to be £12,641 and the expenditure £9,845.

In the Papal States an Anglo-Indian company has been formed for establishing a complete system of railway communication. The Pope is stated by the *Journal des Debats* to have obtained from the French Government copies of all the statutes relating to railways.

Mont Blanc, this summer, appears for the first time this many years, discrowned. The sun has robbed "the monarch of mountains" of his insignia of royalty; neither "the avalanche is in his hand," nor does the "diadem of snow" remain upon his brow.

Navigation of the Seine.—The French Chambers have voted 26,000,000 francs for the improvement of the Seine navigation. Near the mouth of the river the channel will be narrowed, in order that the current by its increased rapidity may constantly act to scour the passage.

Mr. Hudson's railways.—The following table exhibits the average of fares per hundred miles on the railways under Mr. Hudson's management and eleven other railways:—

	1st. Class.	2nd. Class.	3rd. Class.
Hudsonian lines	24s. 7d.	16s. 6d.	13s. 4d.
Eleven other lines	18s. 9 1/11 d.	13s. 7 1/11 d.	8s. 9 8/11 d.

In one case (the Great North of England), 17s. 9d. per 100 miles is charged for *second* class passengers, while on the London and Birmingham the *first* class fare for the same distance is 16s. 6d!

The Birmingham Town Hall has been decorated in the Polychromatic style.

The Masonic Hall, Cowes.—A long account of the laying the first stone of this building has been given in the newspapers, The *Illustrated London News* publishes the design, which appears to be perfectly disgraceful. It has been observed, among other things, that the Grecian-Doric pilasters are twelve diameters in height!

The Sailor's Home, Liverpool, is to be erected in the Elizabethan style from designs by Mr. Cunningham. It has been calculated that the ceremony of laying the foundation stone by Prince Albert has cost more than will suffice for erecting the building.

St. Michael Heavitree, near Exeter.—This church has been re-erected under the superintendence of Mr. Alexander. The form and details of the former church have been almost exactly repeated.

Trinity Church, Paddington.—The cost of this building is £18,000.

St. John Baptist, Sudbury.—A small church, near the Birmingham railway, has been erected from an excellent design by Messrs. Scott and Moffatt. The style is Decorated; the materials flint, with stone dressings.

All Saints, Harrow-weald.—The first stone of this church has been laid. The design is by Mr. Harrison, in the Early English style.

Frescoes in the House of Lords.—Very favourable reports of the success of Mr. Dyce's labours are in circulation. His mural picture is said to have been recently inspected by the members of the Royal Commission of Fine Arts, and to have given great satisfaction to the distinguished visitors.

Statue of Sir Fowel Buxton.—The competition respecting this statue, which is to be erected in Westminster Abbey, has resulted in favour of Mr. Thrupp. The price is £1,000.

M. Vignon, architect to the Empress Josephine at Malmaison, to Louis Bonaparte when King of Holland, and to Murat, recently died at Paris, at the age of eighty-five.

The Society for building, &c., churches and chapels determined, at their last meeting to grant assistance towards the erection of 11 new churches, the rebuilding with enlargement 7 parish churches, and the enlargement of 19 churches and chapels. The Society, since November last, has contributed £20,360 towards the erection of 69 new churches.

South Devon Railway.—Atmospheric tubes of the increased diameter of 22 inches are said to be in course of formation.

The Midland Counties telegraph, from Leeds to Birmingham, and from Derby to Nottingham and Rugby, has been completed at a cost of £40,000.

Instruction of engine drivers.—The French Minister of Public Works has resolved on instituting a school for this purpose at Paris.

A failure of an embankment on the Sheffield and Manchester railway took place recently, when 3,000 yards of earth fell.

The Richmond line is opened. It cost only £170,000, though the original estimate was £260,000. Mr. Locke is the engineer: the rate of progress was a mile a month.

Foreign competition with English manufactures.—The merchants of Birmingham have been offered Belgian wine-glasses and tumblers 25 to 35 per cent. cheaper than they can be produced in England.

The newspapers announce the death of Dr. Bostock, of Liverpool, an associate of Priestly and Davy in their labours. His principal work was the "Elementary System of Physiology."

Discovery of an ancient forest.—In excavating the new road from Woodside, which has been commenced by the Birkenhead commissioners, the workmen have discovered a forest six or eight feet below the level of the soil. Many of the trees retain their original forms almost perfectly.

The Newfoundland Times asserts, from observations of the sea level, that all the land about Conception Bay, and probably the whole island, is gradually rising above the sea.

Chichester Cathedral.—A rose window has been placed in the east gable. The tomb of Richard, bishop of Chichester (1252), has been restored and placed in the south transept.

London Docks.—A new warehouse is being erected by Mr. W. Cubitt. The length of the new building is 234 feet, the breadth 189 feet, and it is five stories in height.

The *Hotel de Ville* of Aix-la-Chapelle is being restored. In this building took place the congress by which the celebrated treaty of Aix-la-Chapelle was concluded.

Railway Legislation of the Present Session.—3,672 miles of railway have been authorized, with a capital of £90,500,000, and power to borrow £38,700,000 more.

London and North-Western.—In consequence of the grand amalgamation of the London and Birmingham, the Grand Junction, and the Liverpool and Manchester, into one great company, named the London and North-Western, most extensive improvements are contemplated. At Euston-square and Camden-town whole streets will be demolished to gain additional space. The Wolverton and the Crewe stations will be greatly enlarged; but the most important alterations are being carried on at Liverpool: there will be a tunnel right under the town of considerable length.

The Contracts for the Menai Tubular Bridge are distributed as follows: Mr. Walter Williams, 2,000 tons of best iron plate; Bramah and Co. and Foster and Co., each 1,500 tons; Thorneycroft and Co., the Colebrook Dale Company, and the Butterly Company, each 1,000 tons;—in all, 8,000 tons.

The Railway of the United States extend over 10,500 miles.

The late Storm has considerably injured the external masonry of Henry

VIIth's Chapel, which, notwithstanding the comparatively recent restoration, shows signs of general decay. It is of Bath stone.

The Government School of Design.—The annual meeting for distribution of Prizes has recently taken place. This institution has effected little which would induce the public to respond to the tone of gratulation adopted in the annual report.

The Three New Parks at Manchester have been opened.

The Restorations at Ely Cathedral progress rapidly. The tombs of Bishop Alcock and Cardinal de Lidanborough, the Purbeck marble shafts of the triforium and clerestory, the corbels, string courses, &c., have been purged of the coatings of paint and plaster. But the chief works are at the west end, where the towers have been restored and opened to the nave. The Chapel of St. Catherine, which opens into the newly-restored transept, is to be repaired. At the east end of the church, the south pinnacle, which was never finished, is in course of erection at the expense of Mr. Hope. The dean has restored Prior Cranden's Chapel.

MISCELLANEA.

Rocket Making in the Royal Arsenal at Woolwich.—The outside case of the rocket is of thin sheet iron, and the inner case of paper. This case being fixed, a ladlefull of clay is placed at the bottom of the rocket and the composition is then poured in; one ladlefull being put in at a time. Each complement of the composition is then driven down by an instrument called a "monkey," similar to those used in pile-driving, which is allowed to fall on the rammer 60 times. This process is repeated on the addition of each ladlefull of the composition, till the whole tube or case is filled, when it is coated over with clay, which hardens and protects the composition from accident till it is required for use, when the clay is bored through.

Blasting of the White Shell Rocks at Sunderland.—These rocks, which have long been a source of danger to ships entering the port of Sunderland, were examined recently by T. Meek, Esq., engineer. On surveying their form and nature, by means of the diving bell, he satisfied himself of the practicability of their being blasted with gunpowder, and their most dangerous parts removed. The surface was found to consist of rid es of pseudo-magnesian limestone, running in an easterly direction. The highest projecting ridge was not more than two feet six inches below the surface of the water. This being the most dangerous point, it was selected for the commencement of the operations. The first blast loosened and displaced six tons of rock, and by means of two others this portion of the ridge was levelled, and a depth of five feet water at low spring ebbs obtained. Another projecting ridge, not so dangerous, has been lowered and broken up. The operations are still progressing, and much advantage to the port is expected to result from them.

Indian Railways.—The Indian journals, received by the overland mail, are discussing the possibility of constructing the railroads. Mr. Simms, after a fair month's survey, has declined to attempt a regular estimate of the cost of constructing a railway from Calcutta to Delhi. In his general report and guess estimate, however, he sets it down at £15,000 per mile; one bridge alone he estimates at two million rupees. This really appears no extravagant estimate of what it may cost to carry a railway through a country subject to inundations so violent as to sweep the most solid structures away. At this rate, the total expense of a railway from Calcutta to Delhi would be somewhere about twenty million rupees. The Great Indian Peninsular is, at one part of its course, to rise 1718 feet in rather less than six miles and in this portion of it there are two miles of tunnelling and one of cutting through a hard fissured trap. The pass through which these operations are to be conducted leads to a "rugged difficult country."

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM JULY 23, 1846, TO AUGUST 25, 1846.

Six Months allowed for Enrolment, unless otherwise expressed.

Charles William Firchild, of Leamington, in the county of Warwick, for "a new engine for obtaining rotary motion."—Sealed July 23.

Peter Claussen, of Leicester-square, Middlesex, gentleman, for "Improvements in methods of, or apparatus for, propelling and exhausting and compressing air and aeriform bodies."—July 23.

John Tulloh Osborn, of Demerara, now residing in London, Esq., for "certain Improvements in power machines, or machinery for tilling, draining, and otherwise cultivating land, and in the mode or modes of working the same."—July 23.

James Henry Dickson, Esq., Capt. Half-pay, of Cheltenham, for "certain Improvements in saddles."—July 23.

Harold Crease, of Brixton-hill, Surrey, paper stainer, for "certain Improvements in the preparation of paints and colours for decorative and other similar purposes."—July 23.

Francois Henry Bickes, of Mayence, on the Rhine, in the Grand Duchy of Hesse, gentlemen, for "Improvements in distillation."—July 23.

George Henry Fourdrinier, of Hanley, in the county of Stafford, paper-maker, for "Improvements in preparing the materials used in manufacturing earthenware and china, and in printing the designs for ornamenting the same."—July 23.

Edward Hammond Bonsall, of Heybride, in the county of Essex, iron-founder, for "Improvements in implements for ploughing land, and clearing land of weeds."—July 23.

Alfred Vincent Newton, of Chancery-lane, draughtsman, for "certain Improvements in the manufacture of sugar." (A communication.)—July 23.

Thomas Bell, of Don Alkali Works, South Shields, for "Improvements in smelting copper ore."—July 28.

Robert Heath, of Manchester, gentleman, for "certain Improvements in wheels to be used upon rail and other roads which improvements are also applicable to mill gearing, and other similar purposes."—July 27.

John Augustin Alexis Sauvage, of Rue Richer, Paris, for "Improvements in condensing the steam in steam-engines, and in supplying water to steam-engine boilers."—July 27.

Thomas Lucas, of No. 113, Aldersgate-street, London, lozenge manufacturer, for "certain Improvements in the manufacture of lozenges or sweetmeats."—July 29.

Henry Bessemer, of Baxter-house, Old St. Pancras-road, Middlesex, engineer, for "certain Improvements in the manufacture of glass, and in machinery and apparatus connected therewith, and also in silvering or coating glass, parts of which improvements are applicable to the manufacture of tin foil and thin sheets of other metal, or alloys of metal."—July 30.

Robert Mallett, of Dublin, civil engineer, and John Somers Dawson, of Dublin, coach builder, for "certain Improvements in railway carriages, and in the machinery for working railways, parts of which are applicable to other carriages, and to the bearings of other machinery."—July 30.

William George Armstrong, of Newcastle-upon-Tyne, for "an Improved lifting, lowering, and hauling apparatus."—July 31.

Theophile Auguste Dreschke, of Rue Therese, Paris, late an officer of Artillery, in the service of Prussia, and late professor of sacred music at the University of Berlin, for "Improvements in the keys of pianofortes and other keyed musical instruments."—July 31.

John Bayley, of Heaton Norris, near Stockport, manager, for "certain Improvements in machinery or apparatus for spinning or twisting cotton and other fibrous substances." August 1.

Thomas Payne, of Handsworth, near Birmingham, gentleman, for "Improvements in the manufacture of rolls for rolling iron and other metals."—August 4.

Charles Vignoles, junior, of Apperby-bridge, near Bradford, Yorkshire, civil engineer, for "Improvements in employing steam as a motive power."—August 4.

Francois Teychenne, of Redcross square, Cripplegate, feather merchant, for "Improvements in treating stone to render it hard and impermeable, and in colouring the same." (Partly a communication.)—August 10.

George Lodge, of Leeds, Yorkshire, engineer, for "certain Improvements in heating water, generating steam, and saving fuel."—August 11.

Frank Hills, of Deptford, Kent, manufacturing chemist, for "a method or methods of treating certain gases, and manufacturing sulphuric acid, muriatic acetic acid, and certain salts of potash, soda, and ammonia."—August 11.

William Kayser, of Bread-street, Cheapside, London, gentleman, for "Improvements in the manufacture of looking glass." (A communication.)—August 11.

Richard Whytoch, of Edinburgh, manufacturer, for "an improved method of manufacture which facilitates the production of regular figures or patterns on different fabrics, particularly velvets, velvet pile, and Brussels, Wilton, and Turkey carpets, being an extension for the term of five years, to be computed from the 8th day of September, 1846, of letters patent granted to the said Richard Whytoch for the said invention, by his late Majesty King William the Fourth."—August 11.

Charles Dowse, of Camden Town, gentleman, for "Improvements in the manufacture and finishing of fabrics capable of being used as substitutes for paper."—August 11.

William Warcup, of Ashton-terrace, Coronation road, Bristol, civil engineer, for "certain Improvements in the manufacture and arrangement of parts and apparatus for the construction and working of atmospheric railways."—August 11.

Henry Constantine Jennings, of Cumberland-terrace, Regent's-park, practical chemist, for "a new method, or apparatus, or machine, for the better or more economic evaporation of fluids or liquids containing crystalline or other matters to be concentrated or crystallised."—August 11.

Jean Michel Borgognon, of New Broad-street, London, gentleman, for "certain Improvements in producing artificial basaltic lavas." (A communication.)—August 11.

Daniel Sydney Hasluck, of Birmingham, merchant, for "certain Improvements in the manufacture of harness for beasts of burden." (A communication.)—August 13.

John Buchanan, of Queen-square, Westminster, gentleman, for "certain Improvements in ships or vessels, and in propelling thereof, and in securing the same from floatal damage, certain parts of which machinery may be used for motion on land."—Aug. 15.

William Aitken, of Aberdeen, in North Britain, gentleman, for "certain Improvements in two and four wheeled carriages."—August 15.

George Phillips, of Park-street, Islington, chemist, for "an Improved construction and arrangement of apparatus for supporting garden-pots, and improving the growth of plants."—August 17.

Moses Poole, of the Patent Bill Office, London, gentleman, for "Improvements in manufacturing terry and cut piled fabrics." (A communication.)—August 17.

Joseph Gray, of Redcross-street, Southwark, machinist, for "Improvements in gas meters."—August 17.

George Remington, of Park-street, Westminster, civil engineer, for "certain Improvements in locomotive engines, part of which improvements are applicable to marine and stationary engines."—August 17.

Joseph Clinton Robertson, of Fleet-street, London, civil engineer, for "an Improved method of constructing boats, ships, and vessels of wood." (A communication.)—Aug. 17.

George Hinton Bovill, of Millwall, Middlesex, engineer, for "Improvements in manufacturing wheat and other grain into meal and flour." (A communication.)—August 18.

Samuel Haven Hamilton, of Paris, gentleman, for "Improvements in machinery or apparatus, for dredging or excavating." (A communication.)—August 19.

William Crofts, of the Park, Nottingham, for "Improvements in the manufacture of lace and other fabrics."—August 20.

Henry Parry, of High-street, Deptford, gentleman, for "certain Improvements in the manufacture of hats."—August 20.

Matthew Gibson, of Wellington-street, Newcastle-upon-Tyne, machine maker, for "a machine for reaping, cutting grass, and other similar purposes."—August 22.

Maximilian François Joseph Delfosse, of Paris, but now of Regent-street, Esq., for "Improvements in preventing and removing incrustation in steam boilers."—August 25.

James Bishop, of Piccadilly, warehouseman, and Thomas Wood, of Upper Barnsbury-street, Islington, gentleman, for "Improvements in passengers' carriages."—August 19.

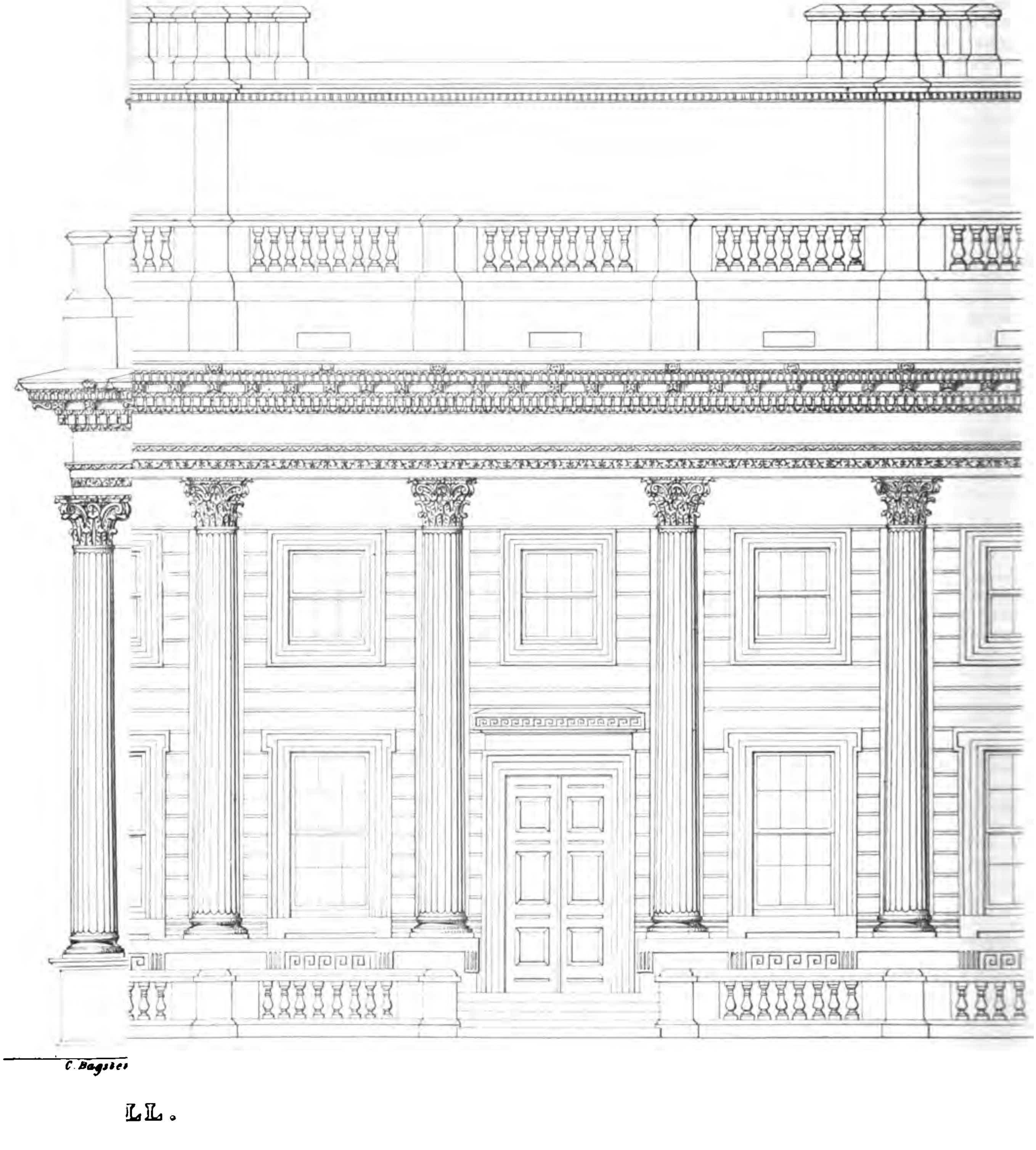
Thomas Russell Crampton, of Adam-street, Adelphi, Middlesex, engineer, for "Improvements in locomotive engines."—August 25.

Alexander Parkes of Birmingham, artist, for "Improvements in the manufacture of candles, and in preparing and combining certain animal, vegetable, and mineral substances, applicable to the manufacture of candles and other uses."—August 25.

James Murdock, of Staple-inn, Middlesex, for a process for "making a composition or artificial stone, applicable to building and other useful purposes."—August 25.

CORRESPONDENTS.

Received "Hodgkinson on the Strength of Cast Iron," "View of Christ Church, Portswood," "Nonnullus." We are again compelled to postpone several papers for want of room. Correspondents who wish to have their communications inserted must send them early in the month.



LL.

THE BOARD OF TRADE, WHITEHALL.

(With an Engraving, Plate XV.)

We have reserved till now, when we exhibit an elevation of it, our remarks on the "Board of Trade," as it was originally designed by Soane, and we may commence them by observing that though he selected a singularly ornate and highly finished example of the Corinthian and adhered to it with that literal exactness which though merely belonging to the province of architectural orthography, is allowed to pass for a positive merit, he deviated widely from—at least did not at all enter into, the spirit of it. Were the rest of the elevation shown before the columns were put in, hardly would it be imagined that the latter were to be of the Corinthian order, least of all that example of it; or *vice versâ*, were it the order that was drawn in first, we should naturally anticipate a corresponding degree of richness for the other features, whereas they are of such marked plainness as to be both inconsistently and affectedly so. It is rather strange that as he did not intend to keep up to tone of the order, he did not adopt the middle course of sobering it down to that of the rest, preserving its proportions and profiles, but retrenching its luxuriance. But like many others, Soane was content to take orders and apply them just as he found them without endeavouring to make them influence the composition. He could copy Corinthian columns—and we are certainly indebted to him for the introduction of the Tivoli example—but he had no clear perception of *Corinthianism*, still less of Ionicism, for his Ionics are intolerable. With all the originality, too, that he possessed, or had the credit of possessing, he does not appear to have ever turned any of it to the composition of a well studied and carefully devised example of his own,—we say example, for we are not so absurd as to expect any one to originate and perfect a new *style* of order—a preposterous idea that has proved a stumbling-block to those who have attempted to do so, and whose extravagant and tasteless conceits have caused those to exult who comfort themselves with that good old orthodoxy which spares them all trouble of invention, and which by making the whole profession mere copyists in regard to the orders, puts all of them so far upon the same level.—But all this may pass for digression, and we therefore break away from it.

In his "Board of Trade," Soane kept up uniformity of intercolumniation, but not to the very great advantage of that portion which had insulated columns, the latter being like the attached ones, four diameters apart; which occasioned in the building what does not show itself in an elevation, more especially an outline one, namely, a certain degree of meagreness as to columniation, at variance with the character of richness aimed at by it, and certainly at variance with the intercolumniation in the original example, where it is only one diameter and a half. Another disadvantage was that the effect of shadow was greatly diminished in consequence of the width of the intercolumns. What is more, those advanced columns were quite as parasitical, and more decidedly for mere embellishment than the others, for instead of the order being a portion of the building, it was merely stuck up against it, the entablature being actually detached from it, and having immediately behind it small windows to a mezzanine floor. It would seem therefore that those columns were brought forward chiefly in order that the entablature might be so also, for the purposing of masking the unsightly apertures required in so ungainly a situation. As an expedient in urgent necessity, such concealment of what would else have blemishes, might have passed for ingenious and legitimate, had not the artifice manifested as much bungling as contrivance by being allowed to show itself; whereas had the soffit of the entablature been closed up, it would not have been even suspected, while at the same time by the entablature being hollowed out, so as to form a mere parapet in front of those windows, the light to them would have been hardly at all obstructed.

In one respect the fenestration of Soane's building was praiseworthy, for the heads of the second tier of windows and their dressings—in builders' phraseology those of the "one-pair"—did not break into the line of the capitals of the columns, owing to which the latter display themselves with more dignity. Nor can we help being of opinion that in this particular point Mr. Barry has not improved upon the original design. We expressed some disapprobation last month of the infraction of linear harmony by the second floor windows being allowed to rise up between the capitals of the order, but we did not mention—in fact had not then considered how the difficulty was to be overcome, the columns being just of the same height as before, and the windows in question considerably taller. As to difficulty, indeed, there was no such word in the case, nothing being more easy of accomplishment, for there was only to raise the columns to the level of the window balustrades, which done, their bases would have ranged with the sills of the first floor windows, and their capitals would have cleared the line of the top of the upper windows. The building would thus have gained an addition of three feet in height, which increase would hardly, we conceive, have been an objection, though decrease of height, to the same extent, might very justly have been so.

Soane's attic looked more like an after thought, and excrescence than as having been designed in conjunction with the order. Instead of contributing any of that play of outline and concomitant piquancy of composition, which so happily mark some portions of the Bank, it produced only monotonous and spiritless heaviness. If that be any great merit, it was certainly free from *Soaneisms*, but unluckily when Soane was not somewhat oddly fanciful he was dull, and sometimes even without a decent idea at command. We have, however, his architectural *autograph* here in some of the chimneys, which have certainly more of Soane than of Corinthianism in them. Pity that with his ambition to be original, he got out of the beaten track only by fits and starts; he jumped out of it only to jump back into it again, or only to jump about the new track he thought he had discovered, but without making any progress in it. He had ideas of his own, but he was apt to put them forth to the public in too raw a state, and he almost invariably left some grating incongruity—some trait of littleness and meanness in every thing he did. His choicest piece of design was the Loggia forming the north-west angle of the Bank—from which, most strange to say, no one has ever taken an artistic lesson in composition.

FENESTRATION AND WINDOWS.

SECOND ARTICLE.

Although there are other characteristics which more or less strongly mark Gothic exteriors, particularly in regard to outline and composition, it is in the apertures alone that the arch, which prevails throughout the entire organization of the interior of the fabric (at least, in ecclesiastical edifices), manifests itself externally, for open arcades corresponding to porticoes, on the outside of buildings are of such exceedingly rare occurrence in the Pointed style, as to be only exceptions. We shall perhaps be reminded of the open arches of porches; but they belong to doorways, and do not form continuous arcades, of which latter, however, or what may else be called a portico of three lofty arches, the front of Peterborough cathedral affords an instance, and is accordingly very remarkable. This comparative absence of the arch from exterior situations has led Schnaase—if we mistake not the writer—to give it as his opinion that the Pointed style seems to have been calculated chiefly for internal effect, inasmuch as it is within buildings that it displays itself in all its completeness and with perfect homogeneousness—not in doors and windows alone, but in a succession of arches, combined with vaulting and its arched surfaces. Externally, therefore, windows are valuable features, because strongly expressive of the style, even should there be, as is sometimes the case, very little besides to indicate it. Nor is it only on account of the presence of the arch in them that they are thus expressive, for in the later Perpendicular the arch is sometimes almost lost, or even entirely so as regards the general form of the aperture, since square-headed windows occur even in ecclesiastical buildings as well as in secular ones; notwithstanding which, the character and constitution peculiar to Gothic windows are strictly kept up. It becomes necessary to consider in what respect Gothic windows are differently constituted from others, and so very much more advantageously, that what renders them both highly characteristic and ornamental externally, renders them also such internally, or *vice versâ*. Perhaps the matter is so exceedingly obvious as to require neither consideration at all, nor explanation,—at least it would seem to be so, for we do not recollect to have seen it adverted to by any one of the numerous writers on the subject; nevertheless, we will, at the risk of putting forth an officious and superfluous observation, lay it down as the distinguishing constitution of Gothic windows, when the style is fully developed, that they consist not of one, but of many apertures united together into a general composition. However large they may be—and they may be extended to any practicable dimensions—they are not mere gaps in the wall; on the contrary, the larger they are the more decorative they become, the increase of size being obtained by an increased number of lights and mullions, and a consequent increase of tracery ribs in the "head" of the window; whereas, unless the general opening were divided in its lower part into lesser apertures, there could be no tracery above.

After the idea of them had been fully developed and brought to maturity, Gothic windows exemplify very strikingly how admirably that disposition of them which originated in convenience if not in actual necessity, was made to conduce to both character and decoration; for the division into separate compartments or "lights," systematically combined into one general whole, resulted in some degree from the exigencies of construction—not indeed as regards the arch which is so filled in, but in order to afford due support, and also the appearance of it, for the glazing and its lead-work. Instead, therefore, of causing mere vacancies and voids in the walls, and of being little better than dull gaps and blanks in the architecture, without any of the bold effect attending unglazed openings, the apertures themselves become positive features in it, they forming so many perforated screens inserted into the arched voids which they occupy. Hence, they differ not only most decidedly but most advantageously from windows in the Greco-Roman and Italian styles, in which ornamental design is entirely confined to the dressings enclosing the aperture, which, however rich they may be in themselves, contribute nothing whatever to internal effect, the aperture itself remaining nothing more than a mere large circular—or square-headed, opening, without any possible variety of design for it; whereas, in Gothic architecture, the actual windows, and not the mere external framing around them, admit of almost inexhaustible diversity; and however plain they may be in their splays and external mouldings, they are both integral and ornamental parts of the structure.

In some instances, however, much external and adscititious decoration is bestowed on Gothic windows,—even such extraneous additions as small crocketed gables enclosing their heads, which therefore seem to offer a direct precedent for the application of pediments to windows in Italian composition, and must accordingly be condemned as gross solecisms,—that is, by those who are intolerant of window-pediments, such gables or Gothic pediments being, like the others, merely "stuck on," and miniature resemblances of constructive forms diverted and perverted from their original intention into mere accessories for the sake of embellishment. Indeed, miniature gables, we may stop to remark, are so exceedingly common in Gothic architecture, that the term *Gablet* has been expressly invented for them; and some of them—*ex. grat.* on the several stages of buttresses—are so diminutive, that they ought to be held very "ludicrous" things indeed by those who adopt the profound dictum that "the lodicrous is inseparable from diminutive resemblances of things noble and dignified in themselves."

To return to windows,—those who denounce the application of pediments and columns to windows in the Italian style, must be equally scandalized at those examples of Gothic windows in which miniature *buttresses* fortify the lower part of the principal mullions, and again, at such enormities as "embattled" transoms. In claiming for Gothic windows the merits and advantages we have done, we must of course be understood to refer to genuine and worthy examples, since we can by no means extend the same praise to that sort of "something like Gothic" that gives us little more than the mere skeletons and rudiments of mullioned windows and tracery,—such as, till very lately, we have been doomed to behold in churches and other modern Gothic buildings, for whose windows, proportions as to the mullions and intervals between them are totally disregarded;—probably, because it has not been even so much as suspected that there are any proportions at all to be attended to. Nevertheless, though it may not have been formally entered among bookish rules, the same principle regulates the spacing of mullions—or, what is the same thing, the breadth of the mullions in proportion to the width of the lights—as regulates intercolumniation. The mullions should not be further apart than 3 or 4 at the most of their diameters, so to call them;—or, in other words, should not be much narrower than from about a third to nearly a fourth of the width of the "lights." It is owing to the non-observance of such proportions that so many modern Gothic windows are very unsatisfactory in character, even when correctly designed in other respects, the mullions being reduced comparatively to mere upright bars, so that the whole window has a wiry and meagre appearance, as offensive to the eye as yawning and straggling intercolumniation, the disagreeableness of which is felt even by those who are unable to account for it. Another point to be attended to, yet frequently disregarded altogether in modern practice, is *systematic uniformity* of division of the windows for all of them alike, both large and small; that is, the width established for the lights in one window should be adhered to for those in all the others, whether the number of lights be more or less; instead of which, modern architects—even those who are very particular and exact indeed in matters that are comparatively quite indifferent and unimportant in compostion—do not scruple to vary the width of lights, just as suits their convenience or their indolence.

f attention to uniformity with regard to the width of the lights seems to be a fettering restriction in Gothic design, there is freedom enough in all other respects as far as windows are concerned, for their dimensions, forms, and position may be varied in the same building, as circumstances require. Nor is it the least recommendation of the Gothic style, that even where exact uniformity, both as to dimensions and general design, is required for windows, they need not be precisely alike in pattern. It is, again, in favour of Gothic windows—at least, for churches and other spacious halls—that even when there is no stained glass in them, the light is considerably moderated by the mullions, transoms, and tracery.

As the value of advantages is generally best appreciated by comparing them with contrary deficiencies, we will now consider how the case stands with windows for churches in other styles of architecture, nor have we long to consider since it is easy to perceive immediately that they have been and continue to be made blemishes in the architecture. Nothing equivalent to tracery has ever been invented or adopted for them, accordingly they are invariably mere vacant though glazed spaces, and as the glass is always of a very ordinary sort and in small panes—in conformity with church etiquette, we presume,—they become actually mean in appearance, and externally present only so many dingy and paltry-looking surfaces, which contrast rather grotesquely with the dressings around them, if these latter are at all noble or elegant in design. The larger too the window the worse does the defect become: the glazing appears insecure and to need support; and no better method, of strengthening it can, it seems, be devised than that of employing sometimes rude metal bars which have an equally mean and clumsy appearance. If Wren's churches in general are not disfigured by their windows, it is—we make bold to say—because there is nothing to be disfigured in them, they being exceedingly uncouth both in composition and style, though there may be a bit of tolerable detail or good feature in their elevations here and there, but the system of design adopted there is radically faulty and tasteless, it being modelled upon the Gothic without possessing any of the qualities or resources of that style: on the contrary, windows which are the source of so much character, beauty and variety in the Gothic style are at the very best only dull, insipid and monotonous features in the other, and to make matters worse, very obtrusive ones. In that otherwise noble edifice, St. Paul's, the windows are sad drawbacks on the architecture generally, both within and without; and within, although there is not that offensive rawness which is occasioned by undue quantity of light scattered in every direction to the destruction of that valuable ingredient—shadow, there is no effect of light—no brilliancy, no relief, for the windows show as so many harsh and cutting spots or holes, in comparison with which the rest looks gloomy. Never do we enter the building without regretting that Wren did not bethink him of getting rid of side windows altogether except those forming the clerestory of the nave; nor would it have cost him much study to do so, the mode of effecting it being obvious enough, for he had only to open the small blind domes in the vaultings over the aisles, and there would have been not only abundance of light but a charming effect of it. In that case the spaces occupied by the present windows would have afforded large compartments for fresco painting, which if such decoration for the edifice was ever contemplated at all, could not have been introduced half so effectively any where else, since the light would diffuse itself upon them from above, and from the nave each picture would have been seen in succession, framed in, as it were, by the arch between the nave and aisle.

At the time St. Paul's was built, *Hypæthral Fenestration*—as we may for distinction's sake call that mode in which the light is admitted from above through the roof of a building, does not seem to have been even so much as thought of, not even for domes, since the light was made to proceed chiefly from windows in the tambour beneath the dome, where they form a circular clerestory. A most noble object externally, the dome of St. Paul's shows itself almost the reverse within, presenting to the eye little more than a mass of sullen gloom, rather increased than the contrary by Thornhill's paintings. It seems therefore to require to be lit up by the most lustrous surfaces and ornaments of the purest white and gilding, which might perhaps sufficiently overcome the obscurity which now prevails in it. As to obtaining a sufficiency of light in a single volume of it by enlarging the eye of the dome, that was and is an impossibility, owing to the great space between the external and internal cupola.

Should the modern Greco-Roman or Italian style be resumed by us for churches—as as it is to be hoped that it will be, at least for those in towns, let us look forward to its being treated in a very different spirit from what it hitherto has been either in the last or present century, and to its being enriched by new elements and combinations. There certainly is abundant opportunity for imparting to it a new and more refined character by correcting it in regard to fenestration, so as to convert what has hitherto been a source of deformity into one of beauty and captivating effect. All the various mode of *hypæthral* fenestration—and they are exceedingly numerous, might be employed according to circumstances, very successfully, although they have hitherto been obstinately rejected for churches,—perhaps with a sort of puritanical horror,—assuredly more for conscience sake than for taste's. We can, however, vouch for the equally novel and happy effect produced in a recently built—in fact not yet finished chapel at the West-end of the town, where the light is admitted entirely from above, and on one side only, and in such manner that the windows themselves are not seen on entering, or afterwards, except by standing on the opposite side to them, and looking directly up at them, when they are discoverable, but even then only partially so. The idea thus thrown out—and to us it is quite new—is a valuable and fertile one. Owing to the beautiful effect of light and half-light—and the breadth of chiaroscuro, the interior we allude to is a complete picture. Possibly, the peculiar mode of lighting was forced upon the architect by circumstances of situation and juxta-position to houses; and if so, he has to bless his stars for the felicitous necessity which compelled him to step out of the hackneyed prosaic track of ordinary church-builders into the picturesque, the artistic, and the poetic. How fortunate would it be for many, were they to be equally favoured by untoward circumstances.—Our subject is not exhausted, but we will here close our present paper on it.

GOETHE'S HOUSE.

As the German Diet have resolved on purchasing Goethe's house, and on having it preserved in its present condition, as a monument of national recognition, the following description, derived from the German, and written by one of Goethe's friends, will, we trust, be acceptable to the reader:—

"On a roomy place (square), enlivened by the murmur of a fountain, stands a two-storied house, painted reddish-grey—the windows surrounded by a black border. Although apparently of spacious dimensions, it in no way exceeds the size of the dwelling of a respectable commoner. We pass the threshold, and enter a hall, whose colouring, resembling yellowish stone, renders it of a light and cheerful appearance. We now ascend the staircase, surrounded by a massive entablature, which leads us, by its broad steps, almost imperceptibly upwards. Its breadth must astonish any one, being disproportionate to the other dimensions of the building—occupying, nay absorbing, the whole lower part of the structure. It is interesting to know how it came to be such. During Goethe's stay at Rome, the house presented to him by the Grand Duke was to be finished, and an appropriate staircase was all ready, when the poet saw one at Rome which enraptured him. Having procured a drawing, he sent it to Weimar, with orders to make a similar one in his house. Vain were all remonstraces sent over the Alps;—there was no help but to obey him. When he returned, he saw, not without surprise, this huge structure, which deprived him of the lower part of his house,—ascended it, shaking his head; and never spoke of it afterwards.

In the upper vestibule, the statues of Sleep, Death, and the colossal head of Juno, gaze at the visitor from their mural niches. Roman landscapes and views, also, remind us of that land, after the leaving of which he said he never more enjoyed perfect happiness.

A small yellowish saloon is now opened. There he dined with his guests. Meyer's drawings of antiques, and Poussin's master-pieces, cover the walls; and behind a green curtain he preserved the Aquarell copy of the Aldobrandini nuptials, also by Meyer, which he considered his greatest treasure. The adjoining localities also exhibit only such objects which appertain to *that* period of art, and to that tendency of Goethe. Here, everywhere the past and its recollections speak to us, and to any one familiar with his works,—"the stones have tongues, and the walls features."

A string of historical associations seizes us,—that sensation which alone can make us thoroughly happy; because nothing is here which had not been touched, as it were, by him during the period of his life-apprenticeship;—and to everything new or different, the access was hereafter rigourously prohibited. It is with a deep feeling that we survey those trifles and minor things, in which this great man found such high edification.

To the right of this saloon we see the so-called ceiling-room; it is not known why Goethe thus called it, as all the rooms have ceilings made of stucco. To the left is his blue receiving-room, and behind it the Urbino-room, thus called after a picture of a Duke of Urbino, which Goethe had brought with him from Italy. On the threshold of his receiving-room greets us his friendly "*Salve!*" When he received strangers, he never came the way which we had passed from the staircase, but went from his study by a passage to the Urbino-room, and from thence he stepped forth, prepared and composed. He did not like—

"That moments, blind-passioned and dark-ruled,
Should have their sway."

These, therefore, were the rooms accessible, in the main, during his lifetime. To his study he admitted no one, with the exception of a few of his most intimate friends—Coudray, Müller, Riemer, Eckermann. When the King of Bavaria paid to Goethe his famous birth-day visit, he asked the poet to allow him also a view of the laboratory of his mind. Goethe looked perplexed, and intimated that his study was not adequately fitted up for the gaze of Majesty. The king seemed resigned, but feigned soon afterwards a bleeding at the nose, declined any one to follow him, and ordered the servant to conduct him to Goethe's washing-basin. The fellow, surprised and perplexed, brought him into Goethe's bed-room, which is behind the study, and left him alone, according to the king's desire. He remained long absent. Goethe, at last, went himself to look after the king—and found him in his study, absorbed in the observation of its contents.

The descriptions which I had found in memoirs and travels, of these rooms had all given me but an incorrect idea. I expected a certain splendour, as it might well be met with now in the houses of those who have talent and means to ornament their *alentours*. It was to that supposition that the flimsy words of visitors had led me. They saw *Zeus*, and therefore the walls surrounding him widened in their eyes to temple-halls, resplendent from *his* lustre. Most probably, I should have found myself in the same position then. Now, as we pass through the widowed rooms, illusion vanishes to give way to modest truth. It is a dwelling, comfortable, cheerful, decent, but thoroughly simple, in the fashion of a time rather passed away—in some places even the worse for wear. It is the dwelling of a patriarch, whose best recollections are attached to some piece of furniture, sashes, or colours, of former days, and which he therefore wishes to be preserved around him, even if they have begun to be unseemly, and are fading away into a duller colouring.

The death of the master has now broken the spell; we pass freely through small closets of communication, right through the house, to his library and study. In one of the rooms, we stopped a moment—it was that in which he dined, when alone, with his children; a blind throws a green shade around. With one step we were in the garden, in which the poet was accustomed, in time of leisure, to enjoy every clear glimpse of the sun. In the corner is a little garden-house, where he used to keep his physical apparatus.

In the fore-room of the museum we saw, in little presses and under glass frames around the walls, minerals, pieces of rocks, shells, fossils—in fact, all which had become a subject of his studies in natural history Everything was kept very clean, and arranged with good taste. A door to the right opened into the library. For such means as were here available, it may appear small; but Goethe purposely did not collect many books, as the libraries of Weimar and Jena were at his disposal — nay, to avoid the accumulation of such sort of treasure, which appeared superfluous to him, he gave away most of what had been presented to him from far and near, after having perused them.

Assistant-librarian Kräuter, clerk to Goethe before he took John as a copyest, now the faithful guardian of this sanctuary, opened the door of the master's study. I recollected from Eckermann's conversations, the occasional allusions of Goethe, which prepared me to find here high simplicity; still, even here, reality was somewhat different. This small, low, unornamented, green cabinet-closet, with the dark blinds of serge, the worn out sills, the nearly decayed frames, was therefore the space whence such an abundance of the most splendid light has poured forth!

Nothing is moved from its place; Kräuter adheres with pious rigour to his charge; every leaf of paper—every worn out pen—remains on the spot where it was when the poet fell asleep. The clock yet shows the death-hour—half past eleven;—it stopped then; an accident almost miraculous! Near it, to the right of the window, stands the small writing-desk, which the grandfather had made for his grand-children, whom, after the death of the father, he took under his care and immediate protection. Wolfgang was his favourite; next to him, Walter; Alma, for the sake of learning to sit still, was obliged to pluck pieces of silk next to her brothers at the little desk. There they are yet, in the envelope of a letter.

Here every spot is holy ground, and a variety of objects, of which the room is full, bespeak the being and actvity of such a mind. Around the walls run rather low presses, in which MSS. and other papers are kept; above are shelves, in which Goethe placed the objects with which he chanced to be occupied. The wood is browned by age, which is much contrasted by a chest of drawers of well polished cherry-wood. It was Goethe's daughter-in-law who gave this piece of furniture to him; but he could not long suffer its insinuating appearance, saying that it "distracted his thoughts." On that account also, there is no object of art in the room, and the visitor seeks in vain for either a looking-glass or a sofa. The latter he was not in need of, on the account that he either stood or moved about the whole day;—he read standing, wrote standing, and even took his breakfast on a high table. A similar conduct he recommended to every one in whose welfare he took any interest, designating it as "life-prolonging,"—as well as the keeping of the hands behind the back, by which, he added, "every narrowing and compressing of the chest is avoided."

Let us look a little more around this reverenced workshop of a great mind! There, at the left of the door, hang a sort of historical testimonials of *character*. Goethe had, at a certain period, written out one column in which was a list of celebrated men and public bodies who, according to his opinion, promised to bear some political fruits; and in the next column was remarked, whether and how far they had yielded, in subsequent years, the result which had been anticipated. Of General Jackson, Goethe had great hopes; his behaviour, however, towards the Indians was subsequently marked in black.

A triangle of pasteboard, which he had himself made, and which occupied the next shelves, is interesting as a sort of physiological *jeu d'esprit*. Goethe wanted to illustrate to himself the action of the powers of soul. The senses (*Sinnlichkeit*) appeared to him the basis of all; to it, therefore, the lower part of the triangle was devoted, and he painted it green. Imagination received a dark red; intellect (*Vernunft*), a yellow; reason (*Verstand*), a blue colour; and occupied each one of the sides. Next to it is a black hemisphere, also of pasteboard, on which, by the aid of a glass ball filled with water, Goethe used to depict all colours of the rainbow, in moments of clear sunshine. With this he could pass his time for hours, especially after the death of his son, and he enjoyed great pleasure when the motley glare was developed right powerfully. And thus he found thorough happiness whenever a phenomenon of nature came within his reach. There stands the small bust of Napoleon, made of opal-flux, which Eckermann brought him from Strasburg, and on which he found confirmed some of the assertions of his doctrine of colours (*Farbenlehre*), which filled him with extacy. A sealed bottle, which we see on one of the tables, he exulted in like a child. There had been some red wine in it, but had long been put aside, and Goethe once holding it towards the light, saw therein the finest crystals of cremor tartari in the shape of leaves and flowers. Like one inspired, he called those around him, ordered a candle, and put, with an air of festivity, his seal of arms on the cork, that no chance should any more destroy this fine phenomenon. The bottle henceforth never came out of his room.

From Napoleon he received revealings in the sphere of light; but he acted also demoniacally upon him from that region, to which, it seems, no ray of an upper world can ever penetrate. On the day of the battle of Leipsig, a medallion of plaster of Paris fell from the wall; a piece of the margin was broken off, without, however, the portrait of the hero being injured. There—in yonder recess—the image is yet to be seen, around which Goethe, parodising Lucan, had placed in red letters: "Scilicet immenso superest ex nomine multum."*

Thus stand's Goethe's house—tasteful, simple, as it behoves the man of mind and letters. A monument of his life and being, it will remain a beacon for others, pointing out the track they have to follow; although there is no person living at present, to whom a similar public recognition could, by any possibility, be ever decreed.

J. L——y.

* Of a great name much remains.

ARCHITECTURAL RECOLLECTIONS OF ITALY.

By Frederick Lush.

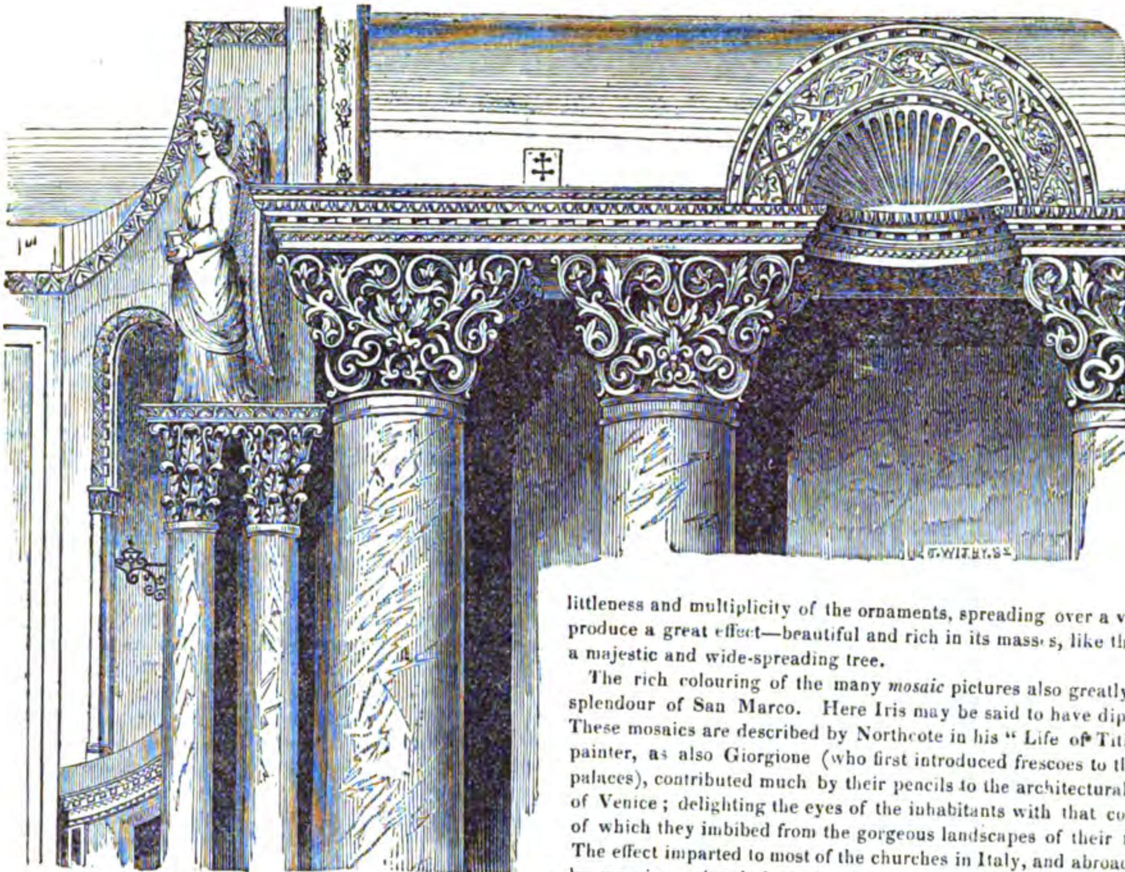
(*Continued from page 264.*)

The dependance of architecture upon painting and the composition of forms, for its most beautiful and majestic effects, and consequently the necessity of studying its principles in the works of eminent painters, was shown merely as an introduction to, or foundation for any remarks which I might subsequently make on the buildings of Italy; for a knowledge of these, forming the judgment to speak accurately upon the effects and combinations of visible objects, seemed the only sound basis for architectural criticism. Writers on art have oftentimes evinced much classic learning, and in some instances much taste; but these are not necessarily connected with each other; in some they are found existing together, though in others not. Wood and Forsyth, to whom the architectural world is indebted for a geat deal of learning, sagacity and research, in some of their critiques, do not appear to have always appreciated those excellencies in Italian buildings which to others were so striking, so obvious, and so often praised. The faculty of looking at them with a painter's eye, seemed to have been deadened, or not called into exercise; the want of perceiving beauty where it existed lying in the temperament or condition of mind under which it was viewed, but sometimes bigotted and pre-conceived notions of what was beautiful, and of a beauty altogether different, perverted their judgment, and they have sentenced a building, as ugly and monstrous, because it was so contrary to their previously imbibed ideas, and exhibited that which was totally at variance with the rules which guided the architects of their own favourite edifices. In these cases, their opinions were produced not upon the feelings or impressions which the objects were capable of making on their minds—or at least on minds not possessed of such antipathies—but from their dissimilarity from other styles to which their thoughts had been restricted.

Now a building which has made a wonderful impression upon myself and many other travellers, is *St. Mark's, Venice*; but this has been severely censured both by Forsyth and Woods. Here it is evident their senses were blind to its magic effects; to those effects at least which other minds differently constituted have experienced. But because they saw beauty in one style of architecture, will they deny it in another? The beauty of one flower differs from that of another—but if we admire the loveliness of the rose, are we to despise that of the lily? Because we have received one kind of emotion in beholding the awful ruins of the Coliseum and have felt the gloomy grandeur of Rome, is the heart incapable of admiring the splendid and magnificent architecture of Venice? The grand simplicity and convenience of the Colisco adapted for the cruel, barbaric daylight spectacles of the Romans cannot be compared with any modern theatre, nor can the massive architecture of the Romans, or the purity and sublimity of the Greeks be placed in juxta-position with the rich fantastic Gothic of Britain, Normandy, and Belgium. But can we infer that one is bad or faulty, because it differs from the other?

It seems that the romance of St. Mark's could in no manner operate on hearts steeled against its influence by a confirmed partiality for the stern, grand, and diametrically opposite features of the Roman school. The dislike to it extended so far with Woods, that in his "Letters," &c.; we find him, after blaming this thing and the other, suggesting such additions and alterations as he thought would improve it. I believe it was the same, or a similar person, who thought it a pity the Parthenon was not surmounted by a steeple! Here the greatest deformity was in the mind, but none whatever in the work, its beauty, along with many another, being that of fitness, whose necessary quality the change proposed would instantly destroy.

The architecture of St. Marks, beautiful in spite of its want of purity and many anomalies, is, as an Italian says, *un grotesco, ma un grotesco magnifico*. Exhibiting a happy mixture of different styles and different materials; making the rules which have limited the conceptions of all other buildings only subservient to its purposes, it can have nothing in common with them, and is put out of the scale of comparison. "There



is no law—says Charles Lamb—to judge of the lawless, or canon by which a dream may be criticised."

Seeing, therefore, by what false criteria St. Marks has been judged, and consequently how the beautiful characteristics of this strange pile, have been misunderstood, I speak in praise of it now, out of pure love and recollection of the feelings which it gave on the spot, and am grateful—as those who have seen and been wrought upon by it must be—for the proud vision which memory frequently brings before the fancy. Its effect on the mind, as well as of the scenery amidst which it is placed, should be pondered over, as a means of raising the taste and increasing our ideas of the beautiful in art.

This Basilica (combining, as it were, the Mosque or Mahommedan house of prayer, with the Christian temple), both in its parts and as a whole, is magical in the extreme. Look for a moment at the profusion and magnificence of its ornaments. The Byzantine-Greeks, unlike their forefathers, avoided the horizontal line as much as possible, and indulged in the curve; the fondness for it resulting from their co-operations with the Saracens; and the communication of the crusaders with the East served to spread it over many parts of Europe.* This love of wavy lines and intricate forms characterises the Venetian architecture, and is most conspicuous in St. Marks. (See the annexed engraving of a portion of the vestibule.) The object of the designers was a great richness of effect—which certainly the nature of the ornaments produced, and often also a grandeur of ensemble,—although, on a close examination into their minutiæ, we find much that is defective: as in the ornate and kindred style of the Alhambra, or that of the Elizabethan. But with all the blemishes in its details, the mind is presented with a view, resulting from the union and consent of so many opposite parts, which is a principal cause of its beauty. The wildness or irregularity in the simplicity of the whole affect the mind with a series of strong impulses, more delightful than that monotonous, though sometimes agreeable, sentiment which is experienced in works built after ordinary rules and common-place precepts. Even the littleness and multiplicity of the ornaments, spreading over a vast surface, produce a great effect—beautiful and rich in its masses, like the foliage of a majestic and wide-spreading tree.

The rich colouring of the many *mosaic* pictures also greatly add to the splendour of San Marco. Here Iris may be said to have dipt the woof. These mosaics are described by Northcote in his "Life of Titian." This painter, as also Giorgione (who first introduced frescoes to the Venetian palaces), contributed much by their pencils to the architectural decoration of Venice; delighting the eyes of the inhabitants with that colour, a love of which they imbibed from the gorgeous landscapes of their native city. The effect imparted to most of the churches in Italy, and abroad generally, by mosaics, painted glass, frescoes, tapestries, carvings, &c., makes one regret that these arts are not more in use amongst us. Or, without referring to the decorated and impressive interiors of the foreign churches, we have eminent examples at home, in the magnificent cathedrals of our Gothic ancestors.

In looking at the rich mosaics in St. Marks, and observing what taste and skill are displayed in shrine, altar, screen, lamps, candelabra, and, in short, every work which the ceremonies and splendour of the church required, we see how every art, that was known at the time, was had recourse to for heightening the effect, both of its exterior and interior. Every object that enriched it, received an additional attraction from, and was in keeping with, the splendid crosses and reliques borne by the processions in the celebration of the festivals;—witness it, for instance, on the festa of *Corpus Domini.* The one absorbing object in its erection and adornment was to render it as splendid and symbolic as possible,—most precious in all materials and workmanship, and to surpass even the Orientals in its magnificence. This was the purport of its inscription: "Istoriis, auro, forma, specie tabularum; hoc templum Marci fore dic decus ecclesiarum." Its interior, though far from "gloomy"—as it has been miscalled—has, it is true, become somewhat dimmed by age and the frequent burning of incense;—but in its palmy days, how bright and glittering must have been its gold! what life and light must it have transfused around, by reflection and refraction!

There is another point for our admiration. Placed in one of the finest piazzas in the world, can anything be conceived more enchanting on such a spot, viewed from the Palazzo Reale, either at noon, when the sun pours its full brilliance upon it; or at night, when the numerous lights below bring out in all their contrast and colours and proportions the wonderful details of its façade;—the moon shedding a bright light on its cupolas and pinnacles, and the dark blue sky around heightening its effect? Can any object be more appropriate than this to Venice? Wealth and gaiety, luxury and romance, make the character of the city,—and the architecture partakes of it. Yet the vesture of mosaics, and gold, and sparkling marbles, in which it is arrayed, seen anywhere else but in Venice, would look like a mountebank in a company of divines.

* An infusion of the Saracenic style is seen in many parts on the continent—from Venice, traces of it along the road to Brescia, and in other directions. The border ornament so common in the Venetian palaces is round the windows of St. Peter's cathedral, Geneva: and the minarets and metal globes on the towers of many churches in Switzerland, give to the towns a rather Eastern appearance. For details, sculpture, &c., of St. Marks, see the works of Cicognara, Zanotto, Kreutser, Canaletti, &c.

NOTES ON ENGINEERING,

VI.

MENAI TUBULAR BRIDGE.

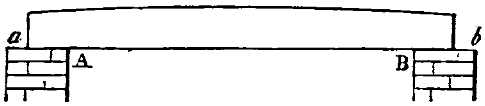
(*Continued from page* 174).

In the last paper on the Menai Tubular Bridge (*ante* p. 174), a formula was given for calculating the *horizontal* strains to which the vertical plates of the tube would be subject, and a truth hitherto entirely overlooked was demonstrated, that these plates ought to be stronger towards their extremities than at the centre.

To complete the investigation of the forces to which these plates are subject, the amount of the *vertical* strains ought also to be determined. But as these papers were already been carried to some length, it is necessary to study brevity; and it will be sufficient to point out the general steps of the calculation.

The vertical plates consist of two different portions discharging two different offices. That part of each vertical plate which lies over the abutments *supports* the upper horizontal plate *upon* the lower: the part between the abutments and clear of them *suspends* the lower plate *from* the upper.

In the following diagram, then, the vertical forces of those parts of the vertical rib which are over A *a*, and B *b*, are thursts, and the vertical forces of the part of A B, tensions. To consider the latter first, let us suppose



sections made at A and B, and that the connection between the upper and lower plates is made not by a continuous rib, but by a number of vertical rods. Then it is clear that we may consider the lower plate and the load on it suspended by means of these rods from the upper plate. We must also take into account the vertical molecular at the sections at A B. But as it is impossible to calculate their amount exactly, it will probably be sufficient for practical purposes to suppose that they sustain half the pressure of the load, and that the other half is communicated by means of the suspending rods to the upper plate. Hence the total tension of these rods will be equal to half the weight of the train + the weight of one of the horizontal plates. If we suppose the rib continuous and not formed of rods, the conclusion will not be widely different. A continuous rib indeed would be *cut* by the section through A and B, but the molecular forces of the rib at the sections would be small compared with the total tension distributed over its whole length.

Hence we conclude that the vertical plates between A and B must together possess sufficient strength that half the load and the weight, one of the horizontal plates may be suspended from them without injuring them.

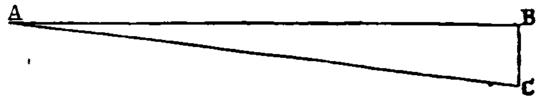
To consider next the vertical thrusts on the portions A *a*, B *b* of the side-plates, it may be easily seen by similar reasoning that these portions support half the load and the weight of one of the horizontal plates resting on them. An important practical conclusion from this is that the portions of the vertical plates over the abutments should be much stronger than the remainder, for they have to resist an equal amount of force distributed over much less surface, and moreover the power of wrought iron to resist thrust is greatly inferior to its power to resist tension.

We cannot conclude this part of the investigation without expressing a conviction that the connection between the upper and lower plates should be maintained, not by continuous plates, but by a lattice of vertical and horizontal rods, firmly clasped together at the points where they cross each other. The necessary strength of them might be calculated with considerable accuracy, they would accommodate themselves far better than continuous plates would to the variations of form produced by changes of temperature, would offer less resistance to the wind, and would admit light and air to the interior of the tube.

7. *Variations of Temperature.*

It may be demonstrated in the simplest manner, that on account of the expansion and construction of the tube from variations of temperature, it would be absolutely necessary that the ends should be left free to move in a horizontal direction.

It is shown by a very common experiment that a plate of metal if fastened in a horizontal direction between two props, and then considerably heated, will, if prevented from expanding laterally, become bowed or deflected. The same thing would happen with the tubular bridge if it were so fastened that it could not expand laterally. In order to ascertain the amount of deflection let A B be half of the length of the bridge before, A C



after, expansion. We will first for sake of simplicity suppose A C a straight line. Then B C is the deflection, and

$$BC^2 = AC^2 - AB^2 = (AC + AB)(AC - AB).$$

It is usual to reckon the limits of expansion of iron at $\frac{1}{1200}$ of the length. Therefore if A B be 225 feet or 2700 inches, the expansion to be allowed for is $2\frac{1}{4}$ inches each way, ∴ $AC = 2700\frac{9}{4}$, $AC + AB = 5400\frac{9}{4}$, $AC - AB = \frac{9}{4}$. Hence $BC^2 = 12150$ inches, and $BC = 110$ inches nearly. Therefore the amount of deflection by expansion would be *rather more than nine feet*.

A C has been here assumed to be a straight line: if however we suppose as a probable approximation to the truth that it is a segment of a circle we shall find that the amount of deflection is not materially diminished. It may be ascertained by a laborious numerical operation which it is not necessary here to repeat that the amount will be about 8 feet. It is clear that a much less distortion than this would suffice to fracture the vertical plates, or wrench them from the horizontal plates.

8. *Effect of Wind.*

A subject of the utmost importance with respect to the permanent stability of the Tubular Bridge is its power of withstanding the lateral pressure of wind. It appears from the experiments of Smeaton, detailed in the Philosophical Transactions for 1757, that the extreme pressure of the wind, when blowing violently, is 49·2 lb. to the square foot. This probably is an amount of pressure which the wind rarely exercises except at sea or when confined between hills. It is said, however, that in March last the force of a gale in Scotland, as registered by an excellent anemometer, was 45 lb. to the square foot. We are also to consider that the situation of the Menai Bridge is one exceedingly subject to the violence of storms, and that the sea-winds confined between the high lands on either side of the straits would exert their force perpendicularly upon the Tubular Bridge, which of course crosses the straits at right angles.

We therefore shall not be exaggerating if we estimate that 45 or 50 lb. per square foot is the amount of lateral pressure which the tube ought to be capable of resisting. In this case we shall find that as the area of one of the vertical sides is 13500 square feet, each span of 450 feet would sustain a pressure of 271 or 301 tons.

Now the utmost vertical pressure which the weight of a train will exert on the same length of the bridge is 200 tons—that is 71 or 101 tons less than the lateral pressure of the wind. It would therefore seem to follow that whatever precautions be necessary for vertical strength are still more necessary for lateral strength, and if it be requisite to strengthen the top and bottom of the tube by a collection of rectangular cells or compartments, the same apparatus (or rather one much stronger) ought to be applied to the sides of the tube. It is quite impossible to assign any solid reason for preferring the consideration of vertical strength to that of lateral, or for endeavouring to obtain the two kinds of strength by dissimilar methods. For it is clear that if the apparatus of cellular compartments be the best possible for ensuring strength vertically, it is also the best for ensuring strength laterally.

It might be answered perhaps that the cellular compartments give to the top and bottom of the tube an excess of strength which will never be required in practice: but then it may be replied that this excess of strength is just as requisite for the sides of the tube; for the effects would be equally disastrous whether the structure broke laterally or vertically. If the tube require an excess of vertical strength, it equally requires an excess of lateral strength: if it do not require an excess of lateral strength, neither does it of vertical. In which latter case the cellular compartments are simply superfluous.

The force of the wind on one span only of 450 feet has been reckoned. If we calculate the force of the two spans of that length, and the force on the two smaller spans of 250 feet each, we shall have the total force tending to overturn the piers or otherwise displace the structure.

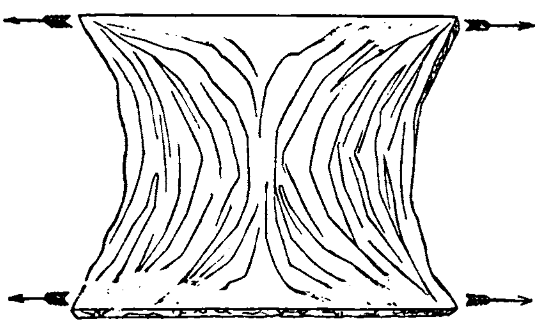
9. *The best form of the upper and lower sides.*

In calculating the strength of the tube, the course taken in the preceding parts of this investigation has been to estimate the sectional area of the metal composing the upper and lower sides of the tube, and to suppose the strain equally divided over the whole area. In order however that the latter assumption may obtain, it is necessary that the top and bottom of the tube should be of a particular form. We shall proceed to show that where the top and bottom consist of continuous plates, extending from one side of the bridge to the other, or where they are formed of cellular compartments such as those described in another part of this Journal, the above requisite is not answered, but that on the contrary, a large proportion of the metal is placed where it is almost entirely inoperative, and that consequently any calculation founded on the supposition that this metal contributes to the strength of the tube must lead to dangerous results.

If the reader will take hold of the page which he is now perusing, at the top and bottom, and pull it, he will see that if the paper were torn the rent would commence somewhere in the neighbourhood of the straight line joining his two thumbs. If, for example, he held the paper by the two right-hand corners the rent would commence on the right side of the page, and the material on the left side would contribute nothing to resist the tearing. Again, if he took the page near the two ends of the black line, separating the two columns of letter-press, the rent would in this case commence in the middle, and the material to the right and left would not under these circumstances contribute anything to the strength of the paper to resist tearing.

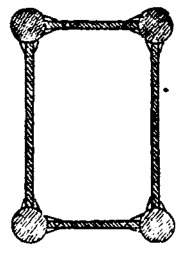
These experiments may appear very simple, and perhaps very puerile. But it is precisely these simple illustrations which give us accurate notions of the action of forces. The case of tearing the paper is exactly analogous to that of tearing the lower plate of the Menai Bridge. It has been shown that owing to the connection of the lower plate with the two side plates, the latter communicate to the former a longitudinal tension which acts all along its two sides. Now this tension is most effective in the immediate neighbourhood of the line in which it acts. If the bridge were overloaded and the bottom plate torn, we are sure that *the rent would commence at the edges, and not in the middle of the plate.*

If a piece of india-rubber, originally square, be stretched by four forces acting in the directions represented by the arrows, it will be found to assume the form here represented; that is, the extension will be greatest in the neighbourhood of the lines joining each pair of opposite forces, and least midway between those lines. In fact if the forces be not too great it is possible to extend the sides of the india-rubber without extending the middle portion at all; so that a small slit made near the centre will remain closed. There is probably some law for the decrease of tension from the sides towards the centre, but there seems no way of ascertaining it except by experiment.

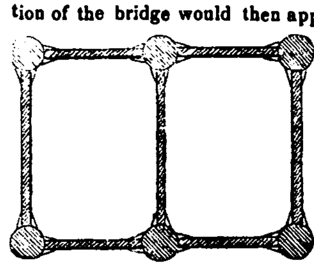


In the recent discussion respecting the Tubular Bridge, in the Mechanical Section of the British Association, it was asserted by Mr. Lamb that provided the top and bottom plates of the tube were of a given sectional area, it was immaterial what proportion the thickness of the plates bore to their width. If this theory be true, it must be true in the limit; and consequently if the top and bottom plates were rolled out till they were no thicker than the finest gold leaf, or the film of a soap-bubble, they should retain their original strength. The mere statement of this notion might be considered a sufficient proof of its absurdity, had not something very similar been sanctioned by high authority. Professor Moseley states in a passage already quoted, that the strongest form of a beam would theoretically be that in which the material of the extended and compressed sides is "collected into two geometrical lines parallel to the neutral axis." Now this would be perfectly true were we dealing with mathematically rigid bodies, but with extensible and compressible substances it seems obvious that the extension or compression could not be uniformly distributed over two indefinitely thin flanges, but would be greatest in the neighbourhood of the vertical rib. Professor Moseley has throughout his investigation assumed that in the vertical section of a deflected beam the extension or compression is proportional to the distance from the neutral axis, and it seems curious that he should have overlooked the fact that in a girder with wide flanges the extension and compression of the flanges also would be, not uniform, but greatest in the neighbourhood of the rib.

We come then with the utmost security to this conclusion, that the strongest form of a beam is one in which the material of the flanges is collected as closely as possible to the upper and lower edges of the vertical rib. This form is very nearly approached in the rails in most general use on our railways, and may be easily imitated in the case of the Tubular Bridge. The accompanying diagram shows a section of the bridge with the principal portion of the material collected at the four angles. If we suppose these four masses to have circular sections, it is easy to calculate what diameter they must have in order to satisfy the conditions of the preceding investigation. It will be remembered that the sectional areas of the upper and lower plates were each taken at 180 square inches, and if the half of this area be assigned to each side of the tube, the area of each of the circles represented in the diagram must be 90 square inches, and the diameter will consequently be about $10\frac{3}{4}$ inches. Let us take the diameter at one foot. Then the thickness of the solid masses at the angles will be equal to one-thirtieth of the height of the bridge. These masses should not be united by continuous plates but braced together by a lattice of iron rods. There are many reasons for preferring open lattice—they are chiefly these—superior strength for equal weight of material, diminished resistance to the wind, admission of light and air to the interior of the bridge, equalisation of temperature by which the danger of distortion by unequal expansion is avoided, and lastly facility of construction.



The bridge is to consist of two parts, containing two parallel roadways. These two parts should be united so as to afford mutual support: the section of the bridge would then appear as in the accompanying illustration. The upper and lower sides of the bridge would be braced together by lattice work similarly to the vertical sides. By these means it will be seen from a mere inspection of the section that the lateral strength would even exceed the vertical. This may be considered another most important advantage arising from the disposition of the material in masses at the angles. If the bridge be covered above and below by cellular compartments extending across it, the same apparatus ought to be applied to the vertical sides, as has been clearly proved; whereas by disposing the material in compact masses it is made to answer both purposes at once—it resists the lateral pressure of wind and the vertical pressure of a train with equal efficiency.



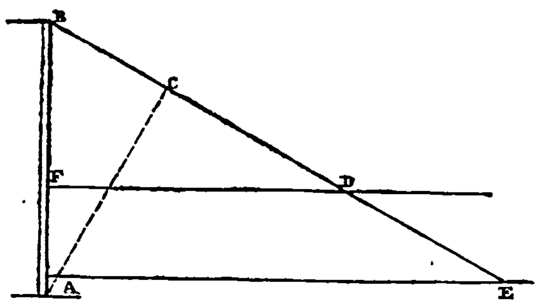
There is one reason more to be assigned for the employment of the upper and lower lattice work. It was observed during one of the recent experiments that the top or compressed side of the tube bulged out transversely; and it may be seen that with a bridge of the construction here suggested, the masses at the upper angles would, when in a state of compression, tend to be similarly bent. They would be likely to be bowed outwards or inwards, and this tendency is restrained by the horizontal bracing. These considerations confirm, to a certain extent, the views of Mr. Byrne, recently propounded in this Journal. The particular mode of calculation adopted by him may fairly be subjected to discussion; but it cannot be doubted that his general views respecting the horizontal transversal strains to which deflected beams are subject, when they tend to break rather by the distortion of the material than the disruption of it, form a valuable addition to the theory of the strength of beams.

10. *The employment of Suspension Rods.*

The reader who has followed the course of the present argument will have no difficulty in understanding that the strength of the bridge depends on the moments of the molecular forces about the abutment—that is, the molecular forces multiplied into their perpendicular distance from the abutment. And it will follow as a necessary consequence of this consideration, that by a proper disposition of suspension rods, an enormous saving of material may be effected.

In some of the published views of the Tubular Bridge, there are represented curved chains, similar to those of common suspension bridges, meeting the tube at a very acute angle. The only points where these suspension-chains are attacked are their extremities, and as they are unprovided with vertical rods, their action is extremely indirect, the greater part of the tension being revolved horizontally instead of vertically. A more inefficient contrivance could scarcely be suggested.

If however *rectilineal* rods be applied according to the plan explained by Mr. Bashforth, in a former number of this Journal, the result is very different. Let the diagram represent a section of part of the bridge and



one abutment-tower. B D E one of the straight suspending rods joining the points D and E of the bridge directly with the top of the tower. Then the perpendicular distance of B E from the abutment is equal to A C, and the moment of the forces about A is the tension of the rod multiplied by the length of A C. This length may be termed popularly the leverage of the rod. But the leverage of the horizontal forces in F D will never exceed A F, the height of the bridge, and consequently the efficiency of the material in B D, over the material in F D is the proportion A C : A F. If we suppose the height of the towers to be 80 feet, (the height of the towers of the Hungerford Bridge), and E to be at the centre of the bridge, we shall find by simple trigonometry the proportion A C : A F equivalent to 2·985 to 1. In other words by putting the material in the form of a straight rod the efficiency is in this particular case nearly trebled.

The enormous increase of strength for a given quantity of material which this reasoning demonstrates ought scarcely to be neglected. Even if we look at the question practically without regard to definite mechanical principles, it seems clear from a mere inspection of the diagram, that the rod B D exerts an upward pull or strain applied directly to sustain the bridge and that the action of F D is comparatively indirect and inefficient.

But there is another great advantage in the use of suspending rods—that they act by tension only. Where the metal is applied to exert a thrust it will give way far sooner by bending than by actual disruption, as the recent experiments abundantly prove: but where it exerts a tension it can only fail by being torn asunder. If it were accidently bent, a thrust would tend to bend it still more,—a tension to straighten it again.

It will be seen by reference to Mr. Bashforth's paper that the effect of the expansion of the rods in summer would be so small that it might safely be neglected, and small as it is, it would be almost entirely compensated for by the expansion of the masonry of the towers. The sinking of the bridge from this cause would not be nearly equal to that due to a heavy load. The rods could never become loose and cease to exert a tension. Even if we suppose they could do so, their value as means of security would still remain the same: for this is certain—the bridge could never actually give way under the effect of a heavy load *until* the rods were broken.

The experiment of the application of rods to the tube has not yet been tried. If this were done, it may be safely predicted that the amount of the breaking weight would be very greatly increased. It would be difficult to calculate beforehand the exact increase of strength, but if the comparison be fairly instituted by experiment between a bridge with cellular compartments and without suspending rods, and one with suspending rods and the material collected in masses at the angles of the bridge, it may be confidently anticipated that the strength would be increased to three times—probably many more times—its former value.

The suspension chain should be relied upon as the principal means of security, the masses at the angles of the bridge as the principal means of rigidity. By thus assigning to each part its separate appropriate office, the efficiency of the whole is most likely to be ascertained.

The preceding investigation has been carried to so great a length that many things are necessarily omitted which are important with respect both to the theory and to the practical construction of the bridge. The circumstance of the experiments being confided into such hands as those of Messrs. Fairbairn and Hodgkinson has prevented the appearance of many suggestions which otherwise might not have been superfluous. If however the remarks here offered conduce to any improvements in the particular structure which has been here considered, or should facilitate the application of simple statical principles to the general theory of the strength of materials, the labour of the writer will not go unrewarded.

H. C.

SETTING OUT RAILWAY CURVES.

Sir,—In reference to Mr. George Heald's communication to you on the subject of laying out railway curves, I beg to say that I have occasionally used a method which is, I think, more simple and accurate, which is as follows:—

Take any given curve, and fix the two extremities of it by two poles and flags. Then run a right line between these two points, which will, of course, be a chord to the curve. Divide this chord line by two, which point of division will be its centre, and each half will = sine of ½ the whole arc, and its versed sine will be the perpendicular to set off at this point; and this *v. s.* is found by multiplying the tubular *v. s.* by radius of curve.

Then proceed to ascertain, in a similar manner, the centre points of each of the two halves of the curves, by running chords, dividing them in two parts, and setting off the perpendicular from the centre by means of its versed line.

When the curve has been divided into a few parts in this way, the small divisions, being now equal and close at hand, may be ascertained by striking one of them on a large size, and, by a scale of equal parts, ascertain the ordinates of one part, which serves for all the other parts.

I am your obedient servant,

An Engineer out of Employment.

Oswestry, July 18, 1846.

[The suggestion above is well worth recording. The method described by our correspondent appears to be very practicable, and is geometrically accurate. Whether, however, this method, or that requiring tables of railway curves, similar to those reviewed by us last month, require the least labour, can only be determined by actual experience.]—Ed.

THE PROBLEMS IN "PLANE SURVEYING."

Sir—Such communications as those of your correspondents, Messrs. Byrne and Turnbull, are little calculated to support the high credit to which your work aspires, and to which by the general ability of your articles it has attained. In common, therefore, with other of your readers with whom I have conversed on the subject, I could not but feel indignant at the unwarrantable pretensions to originality which characterise both; and still more, at the accusation brought by one of them of *bad faith* on the part of the late Dr. Olynthus Gregory. At the same time, it was a source of real regret to see your pages made the medium for claims, which, to say the least, are preposterous; but much as I should dislike any personal dispute, or other intercourse, with either of those writers, I consider that the importance of any otherwise unworthy statement which may appear in your pages, is so far enhanced by that circumstance, that it ought not to be allowed to pass into currency without a caveat from those who set an estimate upon truth, and are themselves cultivators of science.

In the first place, Mr. Byrne's "fundamental principle," upon which he sets such extraordinary value, was given by Carnot, nearly half a century ago, in his *Géométrie de Position*, and in his *Essai sur la Théorie des Transversales*. The application of it to the problems in question have been given over and over by Dr. Gregory in successive editions of *Hutton's Mathematics*, and there they still remain in the last edition of that work, published in 1842, in a form only differing so far from that in your pages as would follow from a wish to conceal their origin. So much for Mr. Byrne's boasted "quality of being original."

With respect to your other correspondent, Mr. Turnbull, I have in the second place to admit, that against his opponent his claim is conclusive for as much as it is worth. That worth is however, inconsiderable, in a practical point of view, at least; and beyond being useful exercises in trigonometrical reduction, they have no scientific value whatever. Under either aspect, no person whose inventive powers in mathematics is of the average order, would consider the discovery worth a moment's dispute. It is to the grave charge made against Dr. Gregory by Mr. Turnbull, (who should have been the last man to make that charge against him) that I take the most decided objection, and to which I will wholly confine my remarks.

It was in your number for October 1845 that I believe this strange charge was first made, and on the same page you refuse to allow any animadversions on Mr. Turnbull's writings—merely from private reasons affecting that person. It must have escaped your notice, at the time of writing that interdict, that you had just marked for press a communication from him which casts a serious imputation upon the memory of a distinguished geometer and truly good man, whose name is justly endeared to the engineering profession.

Now it appears to me that notwithstanding any private considerations affecting Mr. Turnbull, you and the public are entitled to demand of him his *evidences* of the truth of the statement which he makes respecting Dr. Gregory. Mere allegation in such a case is not enough from any man—from Mr. Turnbull certainly not. The question is one between Dr. Gregory's honesty and Mr. Turnbull's veracity: it is a question of *character*, and must not be slurred over as one of no moment. Originality is in this case a question of such minor importance as not to deserve a single thought, except so far as regards its decision upon a question of personal character. I at once apprize Mr. Turnbull that his explanation will be submitted to a scrutiny so rigid, that it will be desirable that he attend more closely to strict accuracy than usual: for the character of public men, and especially of such men as Dr. Gregory, is public property, and will be guarded with corresponding vigilance.

Pending Mr. Turnbull's proofs that Dr. Gregory appropriated his discoveries "without acknowledgment of the source from which they were derived," I only claim that *due weight shall be given to the admitted characters and known talents of the accuser and the accused*:—and that with this shall be coupled a recollection of the triviality of the scientific part of the question at issue.

I am, Sir, your obedient servant,

VINDEX.

September 15, 1846.

PROCEEDINGS OF THE BRITISH ASSOCIATION.

The British Associaton for the Advancement of Science held its annual meeting at Southampton during the past month. The President's address appears on another page. The following report contains merely a selection of those parts of the sectional proceedings most interesting to the engineer. The proceedings of the mechanical section are the most fully noticed, and are followed by some editorial notes. The report will be concluded next month.

On Thursday, Sept. 10, the General Committee met in the Town Hall over the Bargate, Sir John Herschel in the chair. After the minutes of the committee meetings, Cambridge, were confirmed, Colonel Sabine read the following Report of the Council, being the account of their proceedings since June, 1845:

Report of the Council to the General Committee.

1. The Council have the very satisfactory duty to perform of reporting to the General Committee that the Resolutions of the Magnetical and Meteorological Conference, adopted by the General Committee at Cambridge on the 22th June, 1845, were submitted to the Right Hon. Sir Robert Peel, Bart., by the president, Sir John Herschel, Bart., accompanied by a communication from the Marquis of Northampton, president of the Royal Society, conveying the concurrence of that body in the recommendations contained therein; that they received a very favourable consideration from her Majesty's Government, and that the recommendations connected with the British observations both at home and in the colonies are in progress of being carried out. The resolutions relating to the East Indian observations and surveys have met with an equally favourable reception from the Hon. Court of Directors of the East India Company, and the recommendations which they contained have been approved and sanctioned. In accordance with the resolutions passed at Cambridge, therefore, the Magnetic Observatory at Greenwich is permanently continued upon the most extensive and efficient scale, The magnetical and meteorological observations are constituted a permanent branch of the duties of the Astronomical Observatories at the Cape of Good Hope, Bombay, and Madras, and arrangements are in progress for making them also a permanent branch of the observations to be made at the Observatory at Paramatta. The detachment of the Royal Artillery, by whom the duties at the Cape of Good Hope have been hitherto performed, has been relieved by a permanent increase in the civil strength of the Astronomical Observatory; and in like manner the officers of the Royal Navy and the marines who now form the establishment of the Observatory at Van Dieman's Island, will be relieved as soon as the establishment at Paramatta is completed. The Ordnance observatories at Toronto and St Helena are to be continued until the close of 1848.

With reference to the recommendations relating to magnetic surveys, a magnetic survey of the Indian Seas, by Lieut. Elliot of the Bengal Engineers, has received the sanction of the Hon. Court of Directors of the East India Company, and arrangements are in progress for its commencement. Also, early in the present summer Lieut. Moore, of the Royal Navy, proceeded under the direction of the Lords of the Admiralty to Hudson's Bay, in one of the vessels belonging to the Hudson's Bay Company, for the purpose of connecting the observations of the Canadian Survey with those which the expedition under Sir John Franklin is making in the seas to the north of the American Continent.

In accordance with the recommendation concerning the co-operation of foreign magnetical and meteorological observatories, communications were made, on the application of the president, by the Earl of Aberdeen, her Majesty's principal Secretary of State for Foreign Affairs, to the governments of Russia, Austria, Prussia, and Belgium, from all of whom very favourable replies have been received.

2. The resolution passed by the General Committee to the effect "That it is highly desirable to encourage by specific pecuniary reward the improvement of self-according magnetical and meteorological apparatus, and that the Presidents of the Royal Society and of the British Association be requested to solicit the favourable consideration of her Majesty's government to this subject," has been brought under the notice of government, and favourably received, and arrangements have been made to carry the recommendation into effect. Whilst on this subject, the Council has also much pleasure in noticing that the President and Council of the Royal Society have granted £50 from the Wollaston Donation Fund, to assist in the construction of apparatus devised by Mr. Ronalds for the self-registry of magnetical and meteorological instruments, and which apparatus is in progress of completion at the observatory of the British Association at Kew. The Council are persuaded that the General Committee will view with satisfaction this co-operation of the Royal Society and British Association for objects common to both, and for which the observatory at Kew furnishes a very convenient locality.

3. The General Committee at Cambridge having passed a resolution, "That it be referred to the Council to take into consideration, before the next meeting of the Association, the expediency of discontinuing the Kew Observatory," the Council appointed a committee, consisting of the President (Sir John Herschel), the Dean of Ely, the Astronomer Royal, Professors Graham and Wheatstone, and Lieut.-Col. Sabine, to collect information on the scientific purposes which the Kew Observatory has served, and on its general usefulness to science and to the Association. The report of the committee was as follows:—

"*Kew Observatory*, May 7, 1846.—Present: Sir J. F. W. Herschel, Bart., the Astronomer Royal, Professors Graham and Wheatstone, and Lieut.-Col. Sabine. After an attentive examination of the present state of the establishment, and of other matters connected therewith, the following resolutions were unanimously adopted, viz.:

"That it be recommended to the General Committee that the establishment at Kew, the occupancy of which has been granted by her Majesty to the British Association, be maintained in its present state of efficiency. 1. Because it affords, at a very inconsiderable expense, a local habitation to the Association, and a convenient depository for its books, manuscripts, and apparatus. 2. Because it has afforded to members of the Association the means of prosecuting many physical inquiries which otherwise would not have been entered upon. 3. Because the establishment has already become a point of interest to scientific foreigners, several of whom have visited it. 4. Because the grant of the occupancy of the building by her Majesty, at the earnest request of the British Association, is an instance of her Majesty's interest in, and approval of, the objects of the Association. 5. Because, if the Association at the present time relinquish the establishment, it will probably never again be available for the purposes of science. 6. Because it appears, both from the publications of the British Association, and from the records in progress at the establishment, that a great amount of electrical and meteorological observation has been and continues to be made, and that a systematic inquiry into the intricate subject of atmospheric electricity has been carried out by Mr. Ronalds, which has been productive of very material improvements in that subject, and has in effect furnished the model of the processes conducted at the Royal Observatory: and because these inquiries are still in progress under local circumstances extremely favourable. 7. Because other inquiries into the working of self-registering apparatus, both meteorological and magnetical, are in actual progress at the establishment, and that there is a distinct prospect of the facilities it affords being speedily much more largely profited by. 8. Because the access to the observatory from London to members of the Association will shortly be greatly improved by railroads, and because the local facilities and conveniences of the establishment have been very greatly enhanced by alterations in its relations to the Commissioners of Woods and Forests."

"J. F. W. HERSCHEL, *Chairman*."

In laying before the General Committee the report received from this committee, the Council desires to add the expression of its own opinion in conformity with its resolutions.

4. The Council has received a letter from the honorary secretary of the Literary and Philosophical Institution at Cheltenham, expressing on the part of the members of that Institution deep regret that circumstances have arisen which render uncertain their being able to give the British Association that welcome and generous reception which it would be their desire to do, and which they last year felt they could have done had the Association been so circumstanced as to have accepted the invitation for the summer of 1846.

5. The Council has been informed by a letter from W. R. Grove, Esq., F.R.S., that a deputation has been appointed by the Mayor and Corpora-

tion of Swansea, the principal inhabitants, magistracy, and the country gentlemen of the neighbourhood, and by the members of the Royal Institution of South Wales, to attend the meeting at Southampton for the purpose of inviting the British Association to hold their annual meeting at Swansea at as early a period as may suit their convenience. The General Committee will therefore have before them at this meeting invitations from Oxford, Norwich, and Swansea.

Southampton, Sept. 9, 1846.

Proceedings of Sections.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

President: Sir J. F. W. Herschel.—*Vice-Presidents:* Sir D. Brewster, Prof. Wheatstone, Col. Colby, Dr. Whewell.—*Secretaries:* Dr. Stevelly, Messrs. G. G. Stokes, J. Drew.—*Committee:* Prof. Oersted, M. Svanberg, Prof. Wortmann, Messrs. Allen, W. R. Birt, Hon. and Rev. C. Harris, Messrs. W. S. Harris, R. Aunt, Dr. Lee, Mr. J. Phillips, Rev. Dr. Robinson, Mr. F. Ronaldo, Capt. Sir J. C. Ross, R.N. Mr. J. Scott Russell, Col. Sabine, Rev. Dr. Scoresby, Rev. Dr. Wilson, Rev. R. Walker, Mr. J. A. Dale, Dr. Green, Col. Evorest, Mr. R. W. Fox, Prof. Eicenlohr.

Sir J. F. W. HERSCHEL, President, on taking the chair, explained the objects of the Association.

The first paper read was a Report, "*On Gauss's Magnetic Constants,*" from Professor ERMAN.—The author, after pointing out, by several examples, the uselessness of accumulating, beyond certain bounds, mere observations, without subjecting them to scientific reduction, and the importance now attached on all hands to such reductions—as exemplified in the case of the reduction of all the Greenwich Observations, lately executed by the Admiralty, at the solicitation of the British Association—a work which M. Bessel welcomed in the last moments of his life as the beginning of a new period in astronomy; and, after instancing the fact that the Association had been compelled to discontinue many valuable and systematized courses of meteorological observations, in consequence of the stores of unreduced observations outstripping their power to have them reduced, stated, that the determination of the Gaussian magnetic constants had appeared to them at the meeting at Cambridge last year, of such importance, that a sum of 59*l.* was entrusted to him, for the purpose of reducing certain observations made by him on terrestrial magnetism during the year 1829, at several stations round the earth; and applying them to the purpose of determining those constants for that year. The present report was a statement of the results already obtained from this arrangement. The observations to be reduced had been made by M. Erman, from the year 1828 to 1830, at 650 nearly equidistant stations, along a line encircling the globe between the latitudes 62° N. and 60° S.:—at each station the dip, the horizontal direction, and the intensity had been observed. The labour of reducing these had not only far exceeded that which he (M. Erman) could afford to bestow on it, but even the leisure of an industrious and intelligent young mathematical friend, M. Petersen, to prosecute the task; and the report now detailed the extent to which he had gone in his labours.

"*On the Bands formed by the Partial Interception of the Prismatic Spectrum.*" By Professor POWELL.

"*On the Constitution and Forces of the Molecules of Matter.*" By Dr. LAMING.—This was an elaborate theory of the molecular constitution of matter; applied in forty-two distinct propositions to the explanation of gravitation, temperature, and specific heats of gases, cohesion, affinities, latent heat, volume, disturbances of electrical equilibrium, and other electrical phenomena, with electro motion and electro-chemical decomposition. One remarkable consequence of this theory is, that gravitation depends on the electrical atoms alone; and that hence a positively electrified body must be heavier, and a negatively electrified body, lighter than the same body with its electricity in the ordinarily undisturbed state. This the author proposed to prove experimentally to the Section by an experiment to which he was conducted by the theory, as soon as he could procure a cylinder electrical machine with an insulated rubber. The president proposed that discussion on the communication should be suspended until Mr. Laming had exhibited this experiment.

"*Report on Recent researches in Hydrodynamics.*" By G. B. STOKES.—This report was divided into the following heads:—1. General theories connected with the ordinary equations of fluid motion. 2. Theory of waves, including tides. 3. The discharge of gases through small orifices. 4. Theory of sound. 5. Simultaneous oscillations of fluids and solids. 6. Formation of the equations of motion, when the pressure is not supposed equal in all directions. The first head referred to investigations of a rather abstract nature. Under the second, the researches of Mr. Green, Professor Kelland and Mr. Airy. on the subject of waves, were particularly alluded to, and the accurate agreement of theory with the experiments of Mr. Scott Russell pointed out. The important investigattons of Mr. Airy on the the theory of the tides, were also mentioned. Under the next head were mentioned some experiments of MM. Barré de Saint-Tenant and Wantzel, by which an empirical formula was obtained for the velocity of discharge of air through a small orifice, when the discharge is produced by a considerable difference of pressure. The common formula does not apply to extreme cases. A memoir, by Mr. Green, on the reflection and refraction of sound was then alluded to—a memoir which is remarkable from its bearing on the physical theory of light. The investigations mentioned under the fifth head related principally to the motion of pendulums in resisting media. Mr. Green has solved the problem in the case of an oscillating ellipsoid. The last head contained a notice of the theories of MM. Navier, Poisson, and others on the irregularity of pressure in different directions about the same point. This theory may be considered to be that of the internal friction of fluids.

Dr. WHEWELL thought be had ample reason to congratulate himself and the Section on the success of the advice which he had given when, in the year 1830, his friends Mr. Harcourt and the Dean of Ely, had consulted regarding the proper objects which such an association as the then contemplated British Association should propose to itself. He had then advised that one very prominent object should be the preparation of reports on the actual state of human knowledge in the several departments of science.—and one of the fruits of that advice had been the very able report which had just been presented by his friend Mr. Stokes. When he contracted the present scientific position of British philosophers with what it had been only sixteen years ago, when Britain was vastly behind the continental philosophers, not only in scientific attainments, but even in the knowledge of what had been achieved by others, he could not but congratulate all concerned that that stigma had been so completely wiped away. Dr. Whewell then proceeded to comment on several parts of the report and pointed out the importance of keeping distinctly before the mind the essential difference between two kinds of waves, in one of which the motions of the particles of the fluid were the same from the top to the bottom, in the other, the motions of the particles, while all circular, or rather elliptical, diminished rapidly until at the bottom it became nothing. Of this latter kind a familiar illustration could be had by watching the waves which the wind produced as it swept over fields of standing corn or long grass. He then adverted to the formation of the double wave—an example of which was afforded by the tides at Southampton; and which had been investigated by Mr. Scott Russell in the Forth, and by others at Ipswich. He then briefly reviewed the theoretical researches of Weber, Kelland, and Airy, on the subject of waves; and concluded by saying, that as waves of sound were reflected echoes, so he conceived they must suffer refraction, though the observing of this was attended with experimental difficulties; but that these waves were diffracted, he conceived no one could doubt who would attend to the varying sound of a cascade as you approached it round a bending course, it being at first hidden from sight by interposed rocks, banks, or other obstacles. The President agreed with Dr. Whewell, and not only did he conceive that sound could be reflected, refracted and diffracted, but pointed out several cases, as in some of the phenomena of the tuning fork, where something closely analogous, at all events, to polarization must take place.

"*Notice of a New Property of Light exhibited in the Action of Chrysammate of Potash upon Common and Polarized Light.*" By Sir D. BREWSTER.—The chrysammate of potash, which chrystallizes in very small, flat rhombic plates, has the metallic lustre of gold, whence it derives its name of golden fluid. When the sun's light is transmitted through the rhombic plates it has a reddish yellow colour, and is wholly polarized in one plane. When the crystals are pressed with the blade of a knife on a piece of glass, they can be spread out like an amalgam. The light transmitted through the thinnest films thus produced, consists of two oppositely polarized pencils—the one of a bright carmine red and the other of a pale yellow colour. With thicker films, the two pencils approach to two equally bright carmine red pencils. It is to the reflected light, however, and its new properties, that I wish to direct the attention of the Section. Common light, reflected at a perpendicular incidence from the surfaces of the crystals, or of the films, has the colour of virgin gold. It grows less and less yellow as the incidence increases, till it becomes of a pale bluish white colour at very great incidences. The compound pencil, thus reflected and coloured, consists of two oppositely polarized pencils—one polarized in the plane of reflection, and of a pale bluish white colour at all incidences, and the other polarized perpendicular to the plane of reflection, and of a golden yellow colour at small incidences, passing successively into a deeper yellow, greenish yellow, green, greenish blue, blue, and light pink, as the angle of incidence increases. This very remarkable property, which I have discovered also in some other crystals, is not caused by any film of oxide formed upon the natural surface of the crystal, nor is it the result of any change produced upon the surface by external causes. It is exhibited, under the usual modifications, if the surface of the chrysammate is in optical contact with fluids and with glass: and when the crystal is in the act of being dissolved, or when a fresh surface is exposed by mechanical means, the superficial action of the crystal upon light is in both cases the same. When the chrysammate is re-crystallized from an aqueous solution, it appears in tufts of prisms of a bright red colour, the golden reflection being overpowered by the transmitted light; but when these tufts are spread into a film by pressure, the golden yellow colour re-appears. When the crystals of chrysammate are heated with a spirit lamp, or above a gas burner, they *explode* with a flame and smoke like gunpowder; and, by continuing the heat, the residue melts and a cross of colourless amorphous crystals is left. I have found the same explosive property in the aloetinate of potash.

Dr. WHEWELL conceived this was rather a curious action of the chrysammate and aleotinate of potash on light than any new property of light. The President, Sir J. HERSCHEL, was inclined to agree in that opinion, since nothing was more clearly established than that the colours ultimately exploded by light reflected from the surfaces of bodies depended on the number of superficial particles which the light penetrated in the first instance, and their power of absorbing or extinguishing a portion of that light during that penetration. This had been experimentally decided by thin plates of gold, through all the various shades of that metal, down to the red of copper. Whether the title of the paper, however, exactly agreed with the observed facts or not, all must admit that these facts were most important, and deserving of serious attention. He was not acquainted with the substance—chrysammate of potash—but its properties, both optical and mechanical, seemed to be interesting. The plasticity which it seemed to exhibit in particular occurred to him as curious; and this reminded him of a somewhat analogous property lately discovered in the substance plumbago, or the black lead which pencils are made of. It is well known that that substance can only be obtained in any purity at Borrowdale, in Cumberland, and is lately becoming very scarce. Now, although the powder of plumbago is one of the best materials for preventing friction, or the partial adhesion of other things, yet it has been lately found that the particles of the powder themselves are capable of being made to adhere into a mass—indeed, more compact and uniform in its texture than the best mineral plumbago, by simply inclosing it in a case, extracting the air from among the particles, and subjecting the mass to violent compression.

Professor Powell said that the young gentleman who sat near him was the discoverer of the chrysammic acid, and would, perhaps, be kind enough to describe its mode of production. Mr. Schunck (of Rochdale) said that he had discovered the acid, which was part of the composition of the salt of which Sir D. Brewster's paper treated. It was formed by the action of boiling nitric acid upon aloes, and was one of the last products of that action. The chrysammate of potash was a beautiful and curious salt; and although so plastic as to be readily moulded into thin plates, was yet so sparingly soluble as to require above 1,500 times its weight of water to dissolve it.

"*On Elliptic Polarization.*" By Mr. Dale.

"*On certain Cases of Elliptic Polarization of Light by Reflection.*" By Professor Powell.

"*On some of the Results of the Magnetic Observations made at* General Sir T. M. Brisbane's Observatory, Makerstoun." By J. A. Broun.—1st. *Magnetic Declination.*—The annual diminution of westerly declination at Makerstoun is 5′ 8″. When proportional parts of this have been added to the monthly means, from January 1844, till August 1846, their whole range is only 2′ 1″; that is to say, the mean position of the magnetic needle for any month, freed from secular change, has not been about 2′ 1″ farther west than the mean position for any other month. Mr. Broun conceives that he has found the *annual period* of westerly declination to consist of a minimum at the vernal, and of a maximum at the autumnal, equinox: the mean range being under 1′ 2″. From the observations for 1843, Mr. Broun has concluded that there is a maximum of westerly declination when the sun and moon are in opposition, and a minimum when they are in conjunction; that there is a maximum of westerly declination when the moon has its greatest north, and also when it has its greatest south declination, minima occurring when it crosses the equator. In the *diurnal period*, the double maximum and minimum have been found to exist in each month of the year. In the "Transactions of the Royal Society of Edinburgh," Mr. Broun has given certain results relating to the horizontal and vertical components of the earth's magnetic force; but these results were obtained in scale divisions corrected for temperature by his method. In order to deduce the variations of magnetic dip and of the total magnetic force, from the variations of these components, it was necessary to determine the values of the scale divisions in known units. Mr. Broun had previously shown* the inapplicability of the method given by the Committee of Physics of the Royal Society of London for the balance magnetometer. He now described a method by which the value of the micrometer divisions may be satisfactorily determined. This method will be found in the Introduction to the Makerstoun Observations for 1843. He has applied the same method to the bifilar magnetometer, and has found that the value of the scale divisions, obtained in the way recommended by the Committee of Physics, is also inaccurate for this instrument. With the aid of the values obtained by the new method, the following results have been deduced 2nd. *Magnetic Dip.*—The dip is a minimum when the sun and moon are in opposition. In the mean diurnal period for the year,

The principal	maximum	occurs at	10h.	10m.	a.m.
,,	minimum	,,	5	40	p.m.
A secondary	maximum	,,	2	0	a.m.
,,	minimum	,,	5	40	p.m.

Makerstoun mean time being always used. These periods vary to some extent throughout the year, the principal minimum occurring at 6 a.m. in winter; the two minima being nearly equal to the equinoxes, and the diurnal curve being single in summer. Mr. Broun has found that there is a maximum of dip about four hours and a half before the moon's passage of the superior meridian; a minimum about half an hour after the passage; a secondary minimum about three hours after it; and a secondary maximum about eight hours after it. 3rd. *Total Force of the Earth's Magnetism.*—A minimum occurs when the sun and moon are in opposition, equal maxima near the quadratures, and a secondary minimum at the time of conjunction. In the mean diurnal period for the year,

The principal	maximum	occurs at	5h.	40m.	p.m.
,,	minimum	,,	2	10	a.m.
A secondary	maximum	,,	7	10	a.m.
,,	minimum	,,	10	10	a.m.

The periods of maxima and minima shift about two hours in the course of the year, and in summer the principal minimum occurs at 10h. 30m. a.m. The variations of force with reference to the moon's hour angle were found by Mr. Broun as follows:—The principal maximum occurs about two hours after the moon's passage of the inferior meridian; a secondary minimum about four hours before the passage of the superior meridian: a secondary maximum about one hour after the superior passage; and the principal minimum about six hours and a half after that passage. Curves were exhibited illustrating these results, and also the diurnal motion of a magnetic needle freely suspended in the direction of the magnetic force. From the latter some curious results have been deduced, which will be found elsewhere. It will be enough to mention, at present, that in the mean for the year, the motion from 6 a.m. till 6 p.m. is very trifling; between midnight and 6 a.m. the needle is almost stationary, nearly the whole motion occurring between 6 a.m., noon, and 6 p.m. The end of the needle describes an ellipse whose major axis is at right angles to the magnetic meridian; but the direction of this axis varies throughout the year.

Mr. Hopkins, "*On the relations of the Semi-Diurnal Movements of the Barometer to Land and Sea Breezes.*"—Mr. Hopkins exhibited diagrams, drawn up from Col. Sabine's paper "On the Meteorology of Bombay," of the diurnal temperature curve, total pressure curve, and gaseous pressure curve; with a diagram representing the swelling and sinking of the land and sea breezes; and endeavoured to show that these were inconsistent with the explanation given by Col. Sabine, but harmonised with alternations of pressure caused by the alternate extrication of heat and absorption of it during the alternate evaporations and depositions of water, in the state of clouds and dew.

Capt. Shortrede asked Mr. Hopkins several questions; and, from his own observations in India, extending over many years, must dissent from Mr. Hopkins, as to the manner in which he supposed clouds to form and disperse. The effects he ascribed were disproved by the fact, that several miles inland, where there were no land and sea breezes, the clouds were formed and dispersed in precisely the same manner.

Section B.—Chemistry and Mineralogy.

President: Mr. Faraday.—*Vice-Presidents:* Prof. Grove, Dr. Andrews, Prof. Johnston, Dr. Daubeny.—*Secretaries:* Dr. Miller, Messrs. R. Hunt, W. Randall.—*Committee:* Prof. Rosé, M. Dumas, Prof. Oërsted, Dr. Playfair, Prof. Solly, Mr. J. Prideaux, Prof. Schönbein, Prof. Forchhammer, Messrs. R. Mallett, H. Osborn, W. West, R. Warrington, Dr. Leeson, Messrs. J. Wilson, W. Lucas, T. J. Pearsall, T. Ward, Capt. Ibbetson, Dr. Percy, Messrs. W. Sharpe, T. P. Gassiot, Prof. Connel, Mr. J. P. Joule, Dr. Schunk, Messrs. T. Henry, W. Francis, Rev. J. Barlow, Dr. Letheby, Messrs. P. Johnson, — Maskelyn.

"*On the Presence of Atmospheric Air and Uncombined Chlorine and Carbonic Acid found in the Water of some of the Wells in the Suburbs of Southampton, and their Action on Lead.*" By H. Osborn.—The principal object of this paper was to caution persons residing in the neighbourhood of Southampton, against the use of leaden pipes for conveying water, and to induce them to avoid the use of lead in any form for that purpose, without having the water previously examined in order to ascertain whether it possessed the property of acting upon the metal and holding it in solution. The author brought forward several instances of the serious consequences which had resulted from the use of water impregnated with lead, and pointed out the different solvent principles found in the water; one of which was uncombined chlorine discovered in a spring in the New Forest. The water possessed the property of bleaching brazil paper, and reddening litmus paper by evaporation. The amount of uncombined chlorine was estimated as chloride of silver,—by deducting the amount of the latter contained in 20 ounces of water from that of the chlorine contained in the solid contents, the former weighing 1·2 more than the latter—thus indicating 0·296 of uncombined chlorine, which is capable of uniting with 0·864 of lead, forming 1·16 of chloride of lead in the imperial pint. The lead held in solution by carbonic acid, and the oxygen of atmospheric air, was converted into chromate of lead, and estimated as chloride of lead, which indicated 0·25 or 0·2 of the oxide in twenty ounces of water. The solid contents in an imperial pint were found to vary from one grain to three grains, and to be composed of the chlorides of sodium, calcium, and magnesium, sulphate of lime, silica, and vegetable matter. Notwithstanding the preservative property, which the salts contained in spring water are said to possess, by forming an insoluble crust in the interior of the pipes, it was found that the leaden pipes had been in use for some years, and the action of the water on the lead still continued with as much energy as when they were first laid down, thus showing the presence of the above solvents, and that they met with no resistance from the presence of the saline matter.

Dr. Daubeny made some remarks pointing out the importance of the inquiry of Mr. Osborn, and the necessity of paying attention to the condition of the water supplied to towns through leaden pipes, or received in leaden cisterns.—Mr. Pearsall stated that he found that the presence of lead may be constantly removed from the water by the action of carbon, and that lead may be always separated by well agitating the water in con-

* Trans. Roy. Soc. Edin. vol. xvi.

tact with the air, and mixing up the sedimentary deposits.—The subject excited considerable attention, and many gentlemen joined in the conversation, all of them adducing additional evidence of the importance of investigating the condition of water supplied to large towns.

Section C.—Geology.

President: Mr. L. Horner.—*Vice Presidents:* The Dean of Westminster, Sir H. T. De la Beche, Dr. W. H. Fitton, Mr. W. Hopkins, *(For Geography)* Mr. G. B. Greenhough.—*Secretaries:* Mr. R. A. Austin, Prof. Oldham, Mr. J. H. Norton, *(For Geography)* Mr. C. T. Beke.—*Committee:* Prof. Agassiz, Prof. Ansted, Mons. Le Blanc, Major Clerke, Messrs. C. Darwin, Duncan, Prof. E. Forbes, Mr. G. W. Featherstonhaugh, Mons. Graves, Messrs. R. Hutton, W. J. Hamilton, Capt. Ibbetson, Mr. W. King, Mons. de Koninck, Mr. C. Lyell, Prof. Von Middendorf, Mr R. Mallet, Marquis of Northampton, Mons. de Pinteville, Messrs. W. Sanders, W. Sharpe, Rev. Mr. Walker, Mr. J. Yates, Lieut.-Col, Colby, Messrs. G. W. Ormerod, J. Phillips, Sir P. de M. G. Egerton, Bart., Dr. Pye Smith, Hon. and Rev. C. Harris, Mr. J. B. Jukes, Capt. James.

"*On the Artesian Well on the Southampton Common.*" By R. Keele, Esq.—The town of Southampton has hitherto depended for a supply of fresh water to private wells, which are attached to almost every house. They are sunk through a bed of gravel, and vary in depth from 10 to 20 or 25 feet,—at which depth the London clay is reached. An uncertain quantity has also been obtained from the public water-works, supplied by land springs. These sources being insufficient for a growing town, with 30,000 inhabitants, other modes of supply have long been contemplated. The river Test was considered too distant; and the commissioners could not accede to the terms proposed by the proprietor of the most convenient part of the river Itchen. In November, 1835, Mr. Clarke, of London, made an experimental boring on the Southampton Common, through 80 feet of alluvial strata, 300 feet of London clay, and about 100 feet of plastic clay; and afterwards the boring was extended 50 feet into the chalk. The supply was ample; and an Act of Parliament was obtained for providing the means necessary to construct a well which should supply 40,000 cubic feet of water daily. Mr. Clarke estimated the expense at £7,000. In 1837, a contract was made with Mr. Collyer, who proposed to sink an iron cylinder, having a diameter of thirteen feet, to the depth of 160 feet, and from that point to bore to the further depth of 400 feet, commencing with a bore of 30 inches, and gradually diminishing to one of 20. The estimate amounted to £9,980. The cylinder was found inefficient; and a brick shaft, of 14 feet diameter, was continued to the intended depth of 160 feet. Two pumps were employed to raise the water, which amounted to 4,000 cubic feet per diem. Here, instead of commencing the boring, the brick shaft was carried on, by advice of the consulting engineer. At the depth of 164 feet, the diameter of the shaft was reduced to 11 ft. 6 in. At this period, the candles could scarcely be kept lighted; and an air-tube of zinc, with a pair of bellows worked by the steam-engine, was attached, for the purpose of ventilation. Masses of limestone, five or six tons in weight, had frequently to be raised. There was a considerable escape of gas from the sides and bottom of the well, which, together with the vapour that filled the shaft and the impure air caused by so many men at work, occasioned some alarm. At the depth of 214 feet, the shaft was reduced to 10 feet in diameter; and at the depth of 270 feet, to 8 feet 6 inches. The work was then suspended till more powerful pumps could be obtained. On emptying the shaft, and deepening it 23 feet, the influx of water became so great that iron cylinders, 7 feet in diameter, were again resorted to, instead of brickwork. At 322 feet the brick shaft was resumed; the quantity of water raised by the engine amounted to 30,240 gallons in twenty-four hours. At 380 feet from the top of the well, the plastic clay was reached, and the brick shaft continued through it to the chalk. Little or no sand or water was found in the plastic clay. The work was continued day and night till December 4, 1841, when the shaft was 520 feet deep; about three gallons of water flowed into it per minute, its temperature at the bottom ranging from 61° to 62° Fah. The atmosphere of the well at 50 feet was 54°; at 160 feet, 60°; at 543 feet, 65°. The temperature of water at the surface was 44°. In March, 1842, the shaft measured 562 feet; and the pumping having having been suspended for a week, the water rose 400 feet, amounting in quantity to 21,578 cubic feet. This supply being insufficient, the contractors commenced boring with a 7½-inch augur, attached to a rod, conducted to the bottom of the shaft by an iron tube, fixed in the centre of the well. The total depth of the shaft and boring amounts to 1260 feet; and at the time the boring was suspended the water rose to within 40 feet of the surface. In 1845, during upwards of four months' daily pumping, the delivery of water was at the rate of upwards of 1,500,000 gallons per month; and afterwards, in eight days, the quantity raised exceeded 725,000 gallons. When the pumping was discontinued in November, 1845, the water rose, as before, to within 40 feet of the surface.

Mr. Hopkins, in reply to questions as to the advantage of continuing the operations, and the probable supply, stated that the example of the artesian well at Grenelle was calculated to give confidence in similar undertakings where a general analogy existed. The comparison, however, between Paris and Southampton was not complete. Paris was in the very centre of a tertiary, and probably over the deepest part; the water flowed to it in all directions; the inclination of the beds, too, was gentle; and there were no dislocations. Here, however, the chalk of North Hampshire inclined gradually towards the sea, and, passing under it, rose again, with a much greater inclination, in the Isle of Wight. There was no reason for supposing that Southampton was situated over the lowest part of this basin; and since, in the Isle of Wight, there was an enormous dislocation, there might be other dislocations or fissures in the intermediate space, which might afford an outlet for the water below. The height to which water would rise in an artesian well would be affected by the construction of other wells in its neighbourhood. The first artesian well at Cambridge rose 15 feet above the surface, but other wells had reduced its height to 4 feet below the surface. The borings in these instances were only 4 or 5 inches in diameter; but the supply was large, and independent of the existence of any large caverns or fissures. The water came from the iron sands below the gault clay; it had a slightly ferruginous taste, but was quite good. No water was obtained in the chalk, nor could an artesian well be expected in that formation, which is too permeable to hold water. In conclusion, Mr. Hopkins said that he should himself recommend the continuation of the boring, as the trial was not complete till the beds below the chalk were reached.

Mr. Greenhough remarked on the extent of the dislocation which extends through the centre of the Isle of Wight. He believed geologists had done more good by discouraging hopeless speculations than by encouraging useful experiments; and they would not give a positive recommendation, except from experience. He alluded to the artesian wells of Lincolnshire, in a district before scarcely habitable, on account of the scarcity of fresh water, and the thickness of clay impervious to water. Porous beds, resting upon others which were not porous, could alone afford a supply of water.

"*On the Origin of the Coal of Silesia.*" By Prof. Goeppert, of Breslau. This paper was an abstract of an essay which received the prize offered by the Society of Sciences of Holland, at Haerlem, in 1844. Prof. Goeppert remarks, that hitherto few well-preserved plants had been obtained from the coal itself, but its composition had been inferred from the plants which lie in the associated shales. In the coal-fields of Upper and Lower Silesia, which yield four millions of tons a year, he had met with extensive layers, in which the plants were so well preserved, that he could distinguish coal formed from Sigillariæ from that formed by Araucariæ or Lepidodrendra. In most instances the bark alone was preserved—the specimens being flattened; but the Araucariæ, being much harder than the rest, often retained their woody tissue and medullary rays. The species, 80 in number, were found to be differently grouped in the various coal strata, and also under different conditions; and this, with the delicate preservation of the ferns, the multitude of upright stems, of which 200 have already been observed, and the uniform thickness of the strata over a space of many miles, are considered by the author a proof of tranquil deposition on the present localities. The Silesian coal strata are from 30 to 60 feet thick; a larger portion of which M. Goeppert supposes to have accumulated after the manner of *peat*, during the lapse of time. He has ascertained that, by keeping vegetables in boiling water for three months or a year, they are converted into brown coal (*lignite*), and, by the addition of a small quantity of sulphate of iron, a salt which occurs commonly in coal, acquire, at last, a totally black, coal-like condition.

Sir R. I. Murchison expressed his readiness to receive this explanation for the origin of many extensive coal strato. There were other large coal-fields to which the explanation would not apply at all, the materials having certainly been drifted to a distance by currents of water.

Mr. J. Phillips remarked, that although even fragments of coal-plants were uncommon in the coal of England, yet, with the aid of the microscope, *coniferous tissue* might be detected in much of the fibrous coal, which differed only in being less bituminous than the rest. In the ashes of coal, siliceous casts of vegetable tissue were always to be found; and Mr. Bowerbank had detected traces of structure on the fractured surfaces of ordinary solid coal.

Section F.—Statistics.

President: Mr. G. R. Porter.—*Vice-Presidents:* Sir C. Lemon, Colonel Sykes, Messrs. Heywood, R. Nightingale.—*Secretaries:* Messrs. W. Cooke Taylor, J. Fletcher, F. G. P. Neilson, Rev. T. L. Shapcott.—*Committee:* The Mayor of Southampton, Messrs. W. Duckworth, H. Hallam, M. Phillips, M.P., M. Ricardo, J. C. Sharpe, J. Shuttleworth, T. Tooke, G. S. Kenrick, Dr. King, Mr. M. Milnes, M.P., Capt. Allen, Rev. Prof. Elton.

Among the papers read was "*A Review of the Mines and Mining Industry of Belgium.*" By R. Valpy, Esq., of the Board of Trade. It stated that, as a coal-producing country, Belgium ranked the second in Europe. The ratio of the coal district to the total area is

		Acres.		Tons annually.
Great Britain	$\frac{1}{20}$, or	2,930,000	producing	34,000,000
Belgium	$\frac{1}{22}$, or	335000	„	4,500,000
France	$\frac{1}{210}$, or	630,000	„	3,783,000
Germanic Union..........................				3,000,000

In 1838 the total number of coal-mines in Belgium was 307, with 470 pits in work, and 172 in process of construction, employing 37,171 persons; being an increase of 8,454, or 28 per cent. on the number employed in 1829. The increase of the quantity of coal raised was not accurately ascertained, but it appeared to be about 37 per cent. The average cost of production is 10s. 8d. per ton, and the average price 23s. 1d. for first quality, and 16s 6½d.

for the second quality of coal; the average rate of wages is 1s. 6$\frac{5}{10}$d. per day. The establishments for preparing other mineral productions for market in 1838 were, for iron 221, copper 8, zinc 7, lead 2; the total number of furnaces was 132, of which 47 used coke and 22 charcoal. The total number of accidents from 1821 to 1840 was 1,352, which occasioned severe hurts to 882, and deaths to 1,710, making a total of 2,592 sufferers.

A paper was read "*On Plate Glass-making in England in* 1846, *contrasted with what it was in* 1827." By Mr. H. Howard.—The writer furnished carefully all the materials for establishing this comparison. Amongst other results he stated, that in 1827 plate glass was sold for about 12s. average per foot, to the extent of about 5,000 feet per week; in 1835, for from 8s. to 9s. per foot, to the extent of about 7,000 feet; in 1844, for from 6s. to 7s. per foot, reaching about 23,000 feet; and in 1846, for from 5s. to 6s,—about 40,000 feet per week. The sale is now about 45,000 feet weekly. He mentioned that, in 1829, a plate glass manufactory ceased operations because of the small profit realized when selling at 12s.; while, in 1846, a company, with a paid-up capital of 130,000*l.*, realized a net profit of 30,000*l.* selling at from 5s. to 6s. Looking at this extraordinary increase, in spite of the severity of excise restrictions, the author asks, what would be the probable demand if the price were reduced to 4s. or 3s. 6d. per foot, which, free as the trade now is from excise interference, would yield an ample profit?

Section G—Mechanics. Professor Willis in the Chair.

Vice-Presidents: Rev. Dr. Robinson, Messrs. G. Rennie, J. Scott Russell, W. Snow Harris.—*Secretaries:* Messr. C. Manby, W. Betts, jun.—*Committee:* Messrs. J. Taylor, J. Walker, R. Stephenson, J. Locke, I. K. Brunel, C. Vignolles, W. Fairbairn, E. Hodgkinson, E. W. Dent, W. Chatfield, J. Whitworth, J. Nasmyth. J. G. Bodmer, J. Fincham, R. C. Grantham, T. Hoblyn, Dr. Phipps, M. Ricardo, Mr. R. Roberts, Sir J. Guest, Messrs. Grant, Brockedon, C. H. Gregory, W. Harding.

Dr. Robinson gave an account of a "*Modification of Dr. Whewell's Anemometer*," for measuring the velocity of the wind. He explained to the section verbally the nature of the various anemometers hitherto employed to measure the *force* of the wind, and distinguished Whewell's from them, as a measure merely of comparative *rate*. The fault of it was, that the instrument gave no absolute measure of velocity in miles per hour, and that it reduced the rates to no standard, and therefore the observations made at one observatory were not capable of comparison with those at another. He had applied an observation of Mr. Edgeworth, who was a family connexion of his own, to the construction of such an addition as would render Whewell's anemometer more perfect in this respect. He mounted on a vertical axis three or four arms, carrying hemispherical cups at their extremities. These cups opposed much less resistance to air acting on the concave sides than on their convexities, and in such ratio that uniform revolution was produced, at the rate of *one-third* of the velocity of the wind. From this measure, which would be the same for all sizes of the instrument, and at all places the mean velocity of the wind during a given period could always be obtained in miles per hour. He concluded by reading some of the determinations of his own instrument at the observatory at Armagh.

The Chairman, in giving the thanks of the Section to Dr. Robinson, expressed their sense of the scientific elegance and great practical value of an invention applicable generally to the measurement of velocity of fluids; and he called their attention to the dexterous logical process by which the one definite desired term had been eliminated from a multitude of unknown quantities. as exhibiting an admirable example of the combination of sound mathematical reasoning with sagacious experiment.

Mr. Vignolles read a paper furnished by M. Arago, for the express purpose of being communicated to the Association, at which M. Arago was prevented by illness from attending, "*On a new method of boring for artesian springs*," *by* M. Fauvelle, *of Perpignan, in France*. The paper, which was an abridged translation of M. Fauvelle's own account, stated that—

"In 1833, I was present at the boring of an artesian well at Rivesaltes; the water was found, and spouted up abundantly. They proceeded to the tubing, and for that purpose enlarged the borehole from the top downwards. I was struck by observing that it was no longer necessary to draw the boring tools to get rid of the material, and that the water, rising from the bottom, brought up with it, in a state of solution, all the soil which the enlarging tools detached from the sides.

I immediately observed to my friend, M. Bassal, who was with me—"This is a remarkable fact, and one very easy to imitate; if, through a hollow boring rod, water be sent down into the bore-hole as it is sunk, the water, in coming up again, must bring with it all the drilled particles." On this principle I started to establish a new method of boring. The apparatus is composed of a hollow boring rod, formed of wrought iron tubes screwed end to end: the lower end of the hollow rod is armed with a perforating tool, suited to the character of the strata which have to be encountered. The diameter of the tool is larger than the diameter of the tubular rod, in order to form around it an annular space through which the water and the excavated material may rise up. The upper end of the hollow rod is connected with a force-pump by jointed or flexible tubes, which will follow the descending movement of the boring tube for an extent of some yards. This boring tube may be either worked by a rotatory movement or by percussion with a jumper. The frame and tackle for lifting, lowering, and sustaining the boring tube, offer nothing particular. When the boring tube is to be worked the pump must be first put in motion.

Through the interior of the tube a column of water is sent down to the bottom of the bore holes, which water, rising in the annular space between the exterior of the hollow boring rod, and the sides of the bore-hole, creates an ascending current which carries up the triturated soil; the boring tube is then worked like an ordinary boring rod, and as the material is acted upon by the tool at the lower end, it is immediately carried up to the top of the borehole by the ascending current of air. It is a consequence of this operation that the cuttings being constantly carried up by the water, there is no longer any occasion to draw up the boring tube to clear them away, making a very great saving of time. Another important and certainly no less advantage, is, that the boring tools never get clogged by the soil; they work constantly (without meeting obstructions) through the strata to be penerated, thus getting rid at once of nine tenths of the difficulties of boring. In addition, it should be mentioned, that experience has shown there are no slips in any ground which ordinary boring-rods can penetrate; that the boring tube works at 100 yards in depth with as much facility as when only ten yards down, and that from the very circumstances of its being a hollow rod, it presents more resistance to torsion than a solid rod of equal thickness and quite as much resistance to traction: these are the principal advantages of the new system of boring. Indeed these advantages have been fully confirmed by the borings which I have just completed at Perpignan, in St. Dominico's-square. This boring was commenced on the 1st July, and was completed on the 23rd, by finding the artesian water at a depth of 560 feet. If from these twenty-three days, each of ten hours' work, are deducted three Sundays and six lost days, there remain fourteen days or 140 hours of actual work; which is upwards of one yard per hour, that is, ten times the work of an ordinary boring rod.

In the method I have described, it will be perceived that the water is injected through the interior of the boring-rod. Experience has taught me that when gravel, or stones of some size are likely to be met with, it is better to inject the water by the bore-hole, and let it rise through the boring tube. The additional velocity which may be thereby given to the water, and the greater accuracy of calibre of the tube, allow the free ascent of all substances which may be found at the bottom of the bore hole, and which the former mode of working may not so readily accomplish. I have brought up by this latter way stones of 2½ by 1¼ inches.

The idea of making the water remount through the interior of the boring tube suggests an easy mode of boring below a film (sheet) of flowing water: it would be sufficient to close the orifice of the bore hole hermetically, still however so as to allow the boring tube to work, but yet so that the flowing water should be always forced down to the bottom of the bore hole to find its way to a vent: it would thus draw up and carry away all the detritus. If, in addition to the above, we consider the possibility of making the hollow stem of the boring rod of wood, and of balancing it so that it would weigh no more than the water in which it has to move, the problem of boring to depths of 1100 yards and upwards would appear to be solved.

In the square of St. Dominique at Perpignan, a boring had been carried on upon the old method for upwards of eleven months for the purpose of forming an artesian well, and the water had not been found. Fauvelle placed his new tube alongside the old boring tackle, and soon got down to a depth of nearly 100 yards, when an accident occurred which would have required some days to remedy. Fauvelle decided upon abandoning the bore hole already sunk so deep, and commencing a new one, satisfied that there would thereby be a saving in time. The rate of sinking was equal to four feet per hour of the time the hollow boring rod was actually at work, the depth of 560 feet having been obtained in 140 working hours, for a bore hole of about six inches in diameter.

M. Arago, who had seen the rods of Fauvelle at work, mentions how fully they answered, and that the large powerful tools at the bottom of the hollow boring rod cut easily through the hardest strata; he confirmed the fact of the large sized stones and gravel coming up with the ascending current, himself having watched them. He also mentioned that such was the opinion of the people in the vicinity of Perpignan, and so much was water wanted, that orders for the sinking upwards of 200 artesian wells had been given to Fauvelle. The introduction of this system into this country, especially if combined with the Chinese or percussive system of boring, as practised with bore holes of very large diameter, at the Saarbruch mines, and at many other places on the continent, must be productive of great benefit, and would not merely effect a saving of money and labour, but the paramount advantage of immediately solving the question of the existence of coal, minerals, water, &c."

[By reference to the last volume of this Journal, page 56, it will be seen that a patent was granted to Mr. R. Beart, July 12, 1844, for a method almost identical with that of M. Fauvelle.]—Ed. C. E. and A. Journal.

Sir John Guest asked Mr. Vignolles to explain the system of percussion boring, for the information of those gentlemen present who might not be acquainted with it.—Mr. Vignolles said, instead of boring with augurs or rods, there was a heavy weight suspended by a rope and pulley; and fixed to the bottom of the weight was a tool of the crown form, viz., a circular tool of iron, indented at the bottom. There was no description of rock on which he had tried it that this tool did not penetrate with facility. The prejudice of English workmen, however, had hitherto prevented its introduction in this country; but he had no doubt it would make its way, particularly if it could be combined with Fauvelle's system.—J. Lobb, Esq., Mayor of Southampton, wished to ask a question relative to the applicability of Fauvelle's plan to the boring of the Southampton artesian well They had got to the depth of 1,200 feet with a bore of 6 inches in diameter and the expense had been nearly 20,000*l.*; this system, however, seemed to, diminish the expense of boring in an extraordinary manner; and he wished to ask if it could be applied to the present boring at the Southampton Common?—Mr. Vignolles, as an engineer, had no hesitation whatever in saying that it could be applied without difficulty. If they wanted force to send the water down the tube, they might use a steam-engine.—Dr. Robinson suggested that a deputation from the Section should go to the works of the Southampton well, and inspect them.—Mr. J. Hill said that percussion had long been used in this country. They had used that plan whenever they came to hard substances in the Southampton boring. The rods were drawn up by a windlass, and dropped down a foot or six inches; and after the material was loosened the rods were drawn, and the pulverized material raised up by a cylinder.—Mr. Vignolles said this was different from the Chinese system of percussion, where a rope was used, which saved the trouble and loss of time in drawing the rods. The power required for sending down the water on Fauvelle's plan was much less than might be supposed.—The Marquis of Northampton suggested that a committee of the Geological Section should be invited to accompany the committee from this section.—Dr. Lankester expressed his warm approval of M. Fauvelle's plan, and his opinion of its applicability.—A conversation followed, in the course of which Sir John Guest said the weight of a hollow rod, three inches in diameter, and the iron a quarter of an inch thick, would be less than that of a solid rod of an inch diameter; the weight would be further lessened by the rod floating in water.

Mr. Sharp read a paper on improvements in the construction of gas-meters.

Mr. Ricardo explained the construction of a machine which he had used for registering the velocities of railway trains. An eccentric is keyed on to one of the carriage axles and gives reciprocating motion to a rod which turns a ratchet-wheel by engaging with each of its teeth in succession. By these means, a drum, provided with a paper for indicator-diagrams, is made to revolve with a velocity proportional to that of the train. A separate part of the machine contains the mechanism of a common-clock, attached to which is a tracing pencil, which moves with a velocity proportional to the clock's rate of going. Consequently, the diagrams register the velocity of the trains for every period of time during the transit of the train.

Resistance to Railway Trains.

This paper was of considerable importance, and we are the more glad to have the opportunity of expressing an opinion respecting the formula proposed, because it is the same as that of which Mr. W. Harding recently gave an account before the Institution of Civil Engineers.

Mr. Scott Russell commenced by briefly reviewing the labours of those who had gone before him in the investigation of the subject. The report on the experiments, instituted at the instance of the British Association, concluded by observing that the results were so anomalous, that no satisfactory law could be deduced from them. He had undertaken a large series of experiments, but only collected those on which he could place perfect reliance. The trains varied in size from one one to fourteen carriages. Mr. Russell then exhibited his results in three columns of figures; the first column showing the velocities in miles per hour, the second the resistance experimentally determined in pounds per ton weight of the train, the third the resistance determined by his formula.

It would be seen from the second column that it was not very easy to elicit a law: the resistance was very variable with respect to the velocity; for instance, in certain cases the resistance actually appeared to diminish as the velocity increased. The old theory had been that the total resistance was about 8 lb. per ton, and remained constant at all ordinary velocities. It had been found, however, that this theory was quite untenable. The next improvement was to add for the resistance of air a term varying as the square of the velocity. This, however, was still insufficient to represent the experimental results. He was therefore induced to propose a modification of the formula, which he by no means asserted to be theoretically correct, nor did it exactly coincide with the experimental results; but which, however, came nearer to them than did any of the old formulæ, and might be used till a better one was discovered.

Mr. S. Russell's formula is—

$$R = A p v^2 + B m v + C m$$

where R is the total resistance, A the area of the front of the train, v the velocity, m the weight of the train; B, p, and C empirical constants. The last term of this equation represented the resistance from the friction of the axles. The value of C, as determined by the experiments of Wood and the British Association, appeared to be six pounds per ton, so that the whole of the resistance = 6 times the number of tons weight of the train. The next element of resistance was that of the air, which depended rather on the surface exposed than on the weight of the train. The greater number of experiments under this head were few and inapplicable. Smeaton's were made by observing the rotation of thin disks, which presented no analogies to the present case. It appeared, however, to be pretty clearly established that the total resistance could be deduced from multiplying the area of the front of the train by the square of the velocity, and by multiplying this quantity again by a certain empirical constant, which he had represented by p.

After deducting these two resistances, namely, $A p v^2$ and $C m$, there still remained a considerable residue, which indeed was, in many cases, more than half the resistance determined experimentally. Now the general appearance of this residue was, that it was a quantity varying as the velocity multiplied by the mass of the train; and therefore v being the velocity of the train, m its mass, and B a constant, $B m v$ represented the remaining term of the expression for resistance to trains.

The whole argument turned on this question—Does the expression $B m v$ represent with sufficient accuracy the residue, after substracting from the total resistance, as experimentally determined, the theoretical quantities for friction and resistance of air? In answer to this question, Mr. Russell proceeded to examine the two columns of figures before him, one of them showing the theoretical, the other the practical, resistance. In many cases, the accordance was very exact: in others, he confessed, there were great discrepancies. There were anomalous results in both columns of figures; for instance, in the column of experiments, the resistance to the the train at 32 miles was actually less than it was at 31 miles. In fact, there were frequent instances in both columns of the resistance diminishing when the velocity increased: the resistance at a given velocity was often no greater than, and often less than, the next less velocity.

Mr. Scott next considered the physical causes which would account for the new term. A most important element of resistance was the concussion sustained by the wheels of the carriages as they passed over the joints of the rails. This concussion produced a noise and vibration of the earth, which was sometimes perceptible at extraordinary distances. It was frequently so great as to derange the position of the rails, and was a constant cause of wear and tear of the road. This was one most important element of his new term. Another was the lateral abrasion of the flanges of the wheels against the rails—this abrasion representing, of course, a loss of force. Another loss was occasioned by the vertical movement of the carriages on their springs, which was, from the imperfect elasticity of the springs, equivalent to a loss of *vis viva*. There were other elements of his "remainder" or new term, but these were the principal. In conclusion, Mr. Scott Russell stated that all the experiments were not his own; that some of them were the previous property of the British Association, made on trains descending inclines by their own gravity. The dynamometer which he had employed was an excellent one, made by Morin; it was placed between the tender and the first carriage. He exhibited the diagrams which had been actually drawn by this dynamometer, and which were traced in red ink by a camel's hair brush.

The following is the table referred to:—

Velocity in Miles per hour.	Resistance by experiment in lbs. per ton.	Resistance by formula in lbs per ton.
8	8·0	8·7
14	12·6	13·9
29	16·5	15·7
31	23·3	25·4
32	22·5	22·7
33	22·5	22·7
34	16·6	17·3
35	22·5	22.4
36	22 5	25·5
37	17·5	18·2
39	30·0	31·6
41	22·9	19·6
45	21·7	21·0
46	23·1	23·3
47	33·7	33·1
50	32·9	36·3
51	26·4	23·0
53	41·7	42·1
61	52·6	54·8

Dr. Robinson said that though great credit was due to Mr. Scott Russell for putting the investigation in an improved form, there were still several elements of resietance which he thought ought to be taken into consideration. He then proceeded to write on the diagram-board a formula, of which each term explained some kind of resistance, which he explained as he wrote down the corresponding expression. The loss from concussion at the joints should vary as $(\text{velocity})^2$. The resistance to the motion of the wheels, regarded as separate bodies acted on by the air, was two-fold; and arose, first, from their rotation, secondly, from their longitudinal motion. The one resistance would vary as the velocity; the other, as the square of the velocity. In like manner, the resistance from the air to the carriages themselves was composed of two terms; the one representing the resistance to the front of the train, the other to its sides.

Mr. Sharp thought that Mr. Scott Russell ought to have taken into account many contingencies which occurred in practice, such as the effect of curves in the railway. The axle-friction was far greater in some carriages than in others.

Mr. Roberts confirmed the latter statement: he had constantly observed that the wheels of carriages were out of their proper place, and considerably inclined to the axle. In many cases which he had examined, the divergence from the perpendicular was so great, that the resistance must have been enormous. The learned professor did not, however, appear aware that Mr. Russell's formula applied to the resistance of the *train* only, independently of the engine: nor did he seem to have a very clear idea of the line of argument pursued, for he took occasion during the discussion to observe that Mr. Russell had proved everything experimentally, and that "he had not taken anything for granted," whereas he had taken for granted an integral point of his argument, namely, that the accuracy of the first and third terms of his formula had been proved by the labours of preceding investigators.

After some further observations, Professor Willis closed the discussion by remarking on the reciprocal action of the pistons as a fruitful cause of resistance and loss of power.

[It remains only to give our own opinion on the result of Mr. Russell's labour. On a subject of such great moment to the engineer, a general account of the deductions to be made from the arguments employed in the discussion cannot fail to be acceptable. We must begin then by according to Mr. Russell the merit of having approached the subject in a philosophical spirit. He says that his conclusions are the results of a great number of careful experiments, but he does not dogmatise upon them. On the contrary, he tells us plainly, that his formula has been suggested for want of a better. With respect to the "remainder" term, which constitutes the novelty of his results, he rather asks whether it may not represent physical facts, that asserts that it actually does so. This is precisely the language of a true student of science. While, however, we feel that Mr. Russell has made a step in the right direction, we unhesitatingly deny that his formula will account even approximately for the resistance to trains. There appear sufficient reasons for questioning the accuracy of each of the three terms of his expression. The last ($C\,m$) makes the axle-friction independent of the velocity; whereas it depends materially on the velocity, as we will show. Mr. Russell says that the friction of the axle is proportional to the pressure, and he evidently takes it for granted that the only pressure is a vertical one, namely the weight of the carriage. This looks very like an error of principle, for it is obvious that if no horizontal pressure acted on the axle, the wheel would not move forward. The wheel is subject to two retarding forces,—the action of the rail on its periphery, and the action of the air on its whole surface. Now, these forces both depend on the velocity of the train, and their sum is equal to the accelerating horizontal force on the axle; on the principle that when a body is moving uniformly its accelerating and retarding forces are equal. The pressure, then, on the axle is a function of the velocity, and consequently the axle-friction also depends on the velocity. It may be further observed, with respect to the retarding force on the circumference of the wheel from the rail, that it is made up of three parts—rolling friction on the tire, lateral friction on the flange, and concussion at the joints of the rails. The effect of all these probably, or at all events of the latter of them, depends materially on the velocity, and also greatly affects the pressure, and consequently the friction, on the axle.

Next, with respect to the term ($A\,p\,v^2$), Mr. Russell here assumes that the whole resistance of the atmosphere varies as the square of the velocity of the train. Now it seems certain, that whatever law represents the resistance to the front of the train cannot apply to the wheels; for the latter rotate as well as move forward. The action of the air on them differs so greatly from its action on the rest of the train, that the resistance must be expressed by different functions of the velocity. Moreover, the symbol v ought to express not the actual velocity of the train, but the *relative* velocity of the train and the wind. For if the wind and the train were both moving in the same direction, with the same velocity, the resistance on the bodies of the carriages would be zero. And lastly, whatever function be adopted ought to be a discontinuous one, for this reason: if the wind moved faster than the train, it would urge the train forward and be changed from a retarding to an accelerating force. In this case, v (the relative velocity) would be negative; but v^2 would still remain positive, which it ought not to do. This contingency ought to be provided against. We know that the expression for the motion of a projectile in air is discontinuous: the resistance during the ascent of the projectile is not the same function of the velocity as during the descent.

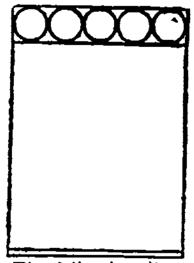
Lastly, in the term $B\,m\,v$, it is assumed, without sufficient data, that all the other resistances besides those of the air and at the axles, vary as the velocity simply. We may decide with absolute certainty, that this cannot correspond to physical facts. The concussion of the joints, for instance, is more likely to depend on the second than the first power of the velocity. It is shown in Moseley's Engineering (p. 594-6), that when a body in motion impinges directly on a body at rest, the mutual pressure at any period during impact is expressed by certain quantities, which represent the hardness of the materials, multiplied by the product of the mass of the moving body into the square of the velocity. There are many other ingredients of the calculation for which it would be difficult to prove that they vary as the velocity simply. It may be also observed, that Mr. Russell's formula frequently did not agree with his own experiments. In about a dozen cases there was an analogy; but the coincidence seems purely accidental, and it would be easy to invent a score of different formulæ which might be supported by similar comparisons.—[Editor C. E. and A. Journal.]

A paper on *Improvements in Steam Engines*, by Mr. Lamb was read. One object of the paper was to suggest an improved method of "blowing off." It was found by experiment that the scales which formed the concretion in boilers were boyed on the surface of the water when boiling, and that they were not precipitated to the bottom till ebullition had ceased. Mr. Lamb proposed to take advantage of this circumstance by putting the blowing off pipe near the surface of the water. The subject of the next paper was

THE MENAI AND CONWAY TUBULAR BRIDGES.

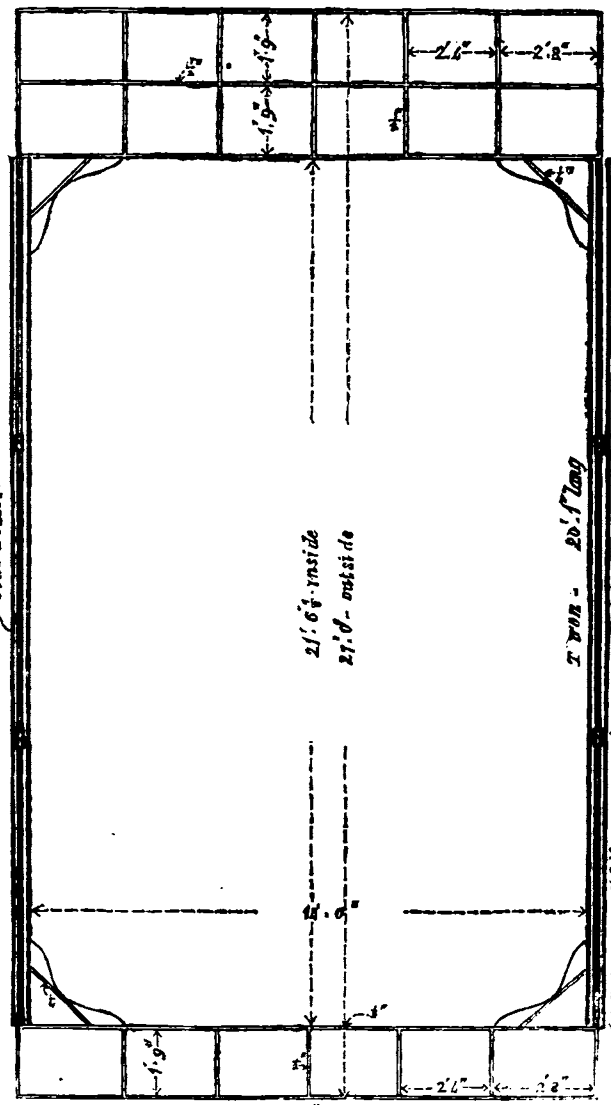
The subject was illustrated by a large number of diagrams, sections, and working drawings; a view of the Menai Bridge with two long and two shorter spans was shown, and on the table was a large model of the bridge which it is proposed to erect over the Conway before the Menai bridge is commenced. The model of the Conway bridge shows a single span; the abutments are two massive towers rising to about twice the height of the tube; the sides of the tube have a series of cruciform apertures for the admission of light and air.

Mr. FAIRBAIRN commenced by detailing the course of the experiments which had been made to ascertain the strongest form of the tube. The tube generally gave way on the upper side, and it was first attempted to strengthen it by making the top plate of corrugated iron. This being found insufficient, the next proposition was that the top of the tube should contain long tubes between two horizontal plates; the form of the section being that represented in the accompanying diagram.



This form was afterwards modified by making the top with rectangular cells or compartments, and a model of this form was made one-sixth the dimensions of the proposed bridge; that is to say, of one-sixth the length, breadth, and height, and with plates rolled as nearly as possible to one-sixth the thickness of those intended to be adopted.

The following diagram represents the section of the model at the middle, and also of the Conway Bridge for which the dimensions will be as follows:—



[Section of the Conway Bridge at the middle.]

Dimensions.

	ft.	in.
Height outside	27	0
" inside	21	6¼
Breadth outside	14	8
" inside	14	0
Thickness of side plates	0	4

Height of each of the three portions which are united to form the side plates	7	2½
Height of rectangular cells at top and bottom	1	9
Breadth of ditto	2	4
(Excepting those at the angles of the tube which are in breadth ..	2	8
Thickness of plates forming the cells		¼

In all the experiments on the large model the weights were suspended at the centre of it, from its lower side. In the first experiment the tube broke with a weight of 35½ tons. It was then thoroughly repaired and the sides were stiffened by vertical ribs attached at intervals throughout their length: by these means and the addition of another plate at the bottom the breaking weight was increased to 56 tons. It was observed in one case that the top of the tube bulged out transversely. The form of joint which was intended for the top of the tube was made by laying the ends of the plates together without uniting them; they were then to be simply overlapped by pieces of metal above and below to prevent them slipping past each other ———. Instead however of adopting this form, the maker of the model had by mistake used a joint of the following form ———, bolting the two plates where they overlapped. In consequence of this arrangement and the great pressure to which the upper side of the model was subjected, the plates slipped some considerable distance past each other, and slits were cut in them by the bolts. The section of the Conway bridge given above, shows one of the vertical stiffening plates attached to each of the sides of the tube. These stiffening plates are T iron ½ inch thick.

Mr. Eaton Hodgkinson said that his own decided conviction was that the best form for the top of the bridge was a series of long hollow cylinders such as those first described by Mr. Fairbairn. There were three forms proposed for the top—solid iron, rectangular compartments and cylindrical compartments. He certainly thought the latter form was the best. In fact the superiority was so great that no difficulty or expense in the manufacture ought for an instant to weigh as an objection to its adoption. The great object was perfect security, and to this every minor consideration of trouble or preliminary outlay ought to be sacrificed.

From the proportions which had been chosen he estimated that the strength to resist lateral pressure was one-fourth of the vertical strength. In his own models the proportions for the side plates were different, and he had laid his tubes on their side to compare the lateral to vertical strength. He found the latter was to the former in the proportion 26 : 15. This comparison he had instituted in order to ascertain the capability of the bridge for resistance to the action of wind. As however the proportions actually chosen for the Conway bridge differed from his own, he had suggested that the strength of the side plates should be increased, and this suggestion had been partially acceded to. He did not think that the top plate should be arched between the abutments as in that case the steam of the engine would rise to the top and have no means of escape. [This by-the-by is a very insufficient objection, and one which might be easily removed by some simple mechanical contrivance.]

Mr. Clark, who had been present during the performance of all the experiments, next read a paper. Each of the longer tubes of the Menai bridge would be 462 feet long, and weigh 1200 tons. It was intended to put all the parts of tube together at a place about a quarter of a mile from the intended position of the bridge. When the structure was finished it would be floated to its place on large barges, and finally raised by hydraulic presses at the two ends simultaneously. The Conway bridge had to be raised only 18 feet, and this work would be completed first. Mr. Clark then read some calculations respecting the strength of the bridge, but they bore so great an analogy to those which have been already published in this Journal, in the Notes on Engineering, that it is not necessary to repeat them. He said also that the tensile strength of the bottom would be proportional to the sectional area, and independent of either the width or thickness considered separately; so that provided the sectional area contained a given number of square inches, it was immaterial what proportion the thickness of the bottom plate bore to its width. [This is one of several grave errors which have been committed in the contrivance of the Tubular Bridge. We do not however consider it necessary to enter on the demonstration here, as it will be given in the Notes on Engineering.]

From the experiments it would appear that the sectional area of the two sides together ought to be equal to that of the bottom plate.

Mr. Fairbairn expressed some surprise that Mr. Hodgkinson should take to himself the credit of suggesting the cellular form for the top of the tube. He could assure him that he was mistaken on this point, as experiments on tubes with cellular tops had been commenced at Millwall before he arrived there. With respect to the pressure of the wind, it would be found that if it be taken at 50 lb. per square foot, the total lateral pressure on one side of the bridge amounts to 300 tons. The proposition of supporting the bridge by suspension chains had been finally abandoned. In order to deaden as much as possible the effect of vibrations from the passage of a train, the rails would be laid on vulcanised india-rubber 2 inches thick.

Dr. Robinson called attention to the difference between laying a load gradually on the bridge and drawing a load rapidly over it. If the impulses from the train were synchronous with the vibrations, the latter would be increased to a frightful extent. He himself had ascertained the vibration of a train at a distance of 15,000 feet by observing the effect on quicksilver. He thought that in the model different loads ought to be drawn through very rapidly to test effects corresponding to those of the passage of trains.

Mr. Fairbairn said he would certainly endeavour to follow out the suggestion.

Mr. Scott Russell said that it appeared to him that the principal question had not yet been discussed. The point to be considered was—not whether the bridge could be made strong enough to bear the weight on it; for there was no doubt that the engineers would keep on adding metal till they removed all chance of fracture—but the real question was whether the requisite strength was attained with a minimum quantity of metal: whether, in fact, the metal was disposed in the most advantageous manner. He had some doubts on this point. If two spans of the bridge were united at the bottom pier, it was clear that any deflection in one span would communicate its effect to those which adjoined it; so that there would be points of contrary flexure, and the line of the bridge would be alternately convex

and concave. In this case the top plate of the bridge would, in the neighbourhood of the pier, be subject to tension instead of compression, and conversely for the bottom plate of the bridge.

Mr. Hodgkinson said the consideration of vibrations from the rapid transit of a train was of the utmost importance. The effect of a train in motion could scarcely be calculated accurately. "I confess," added Mr. Hodgkinson, "that when I consider this subject my mind misgives me, and I cannot help feeling a few tremors." This announcement produced a sensation.

Mr. Roberts said that vibrations might be checked by altering the time of the impulses. It was a common practise of engine-drivers, when they found the engine began to "kick," as they term it, to accelerate or retard the train, and this generally destroyed the vibrations.

Mr. Fairbairn allowed that rectangular compartments for the top of the tube were not theoretically the best, but they were so practically. It was necessary to provide means for the entrance of workmen into every compartment to make any repairs that might be required, or to renew defective plates.

Dr. Robinson said that what was to be apprehended during the passage of trains was not a sudden impulse, but the accumulation of vibrations. It was well known that even a child might set a great bell in motion by continued efforts properly timed. If the impulses communicated by the bell-rope were synchronous with the vibrations of the bell itself, the extent of those vibrations might be increased till the bell got its full swing.

Mr. Hodgkinson said that it had been suggested that the top plates should be of cast iron. He objected to this proposition on the following grounds. From his own experiments on the strength of cast iron, and wrought iron columns to resist pressures applied in the direction of their lengths it appeared that the relative strength of the two materials depended entirely on the length of the columns. The columns might fail either by bending or by crushing. With short columns cast iron bore to wrought iron the strength of 17 : 10, but with long columns the strength of cast iron to that of wrought iron was at 14 : 50. This showed the superiority of the latter material for the upper plates of the tubular bridge.

MICHAEL ANGELO.

A correspondent of the *Literary Gazette* has furnished to that paper some particulars relating to the discovery of certain works by Michael Angelo and other artists of renown. The correspondent is described as a lady married into a collateral branch of the family of the great Italian. A minute search through the Buonarotti Gallery has led to the following results:—"Upon opening the door I found Michael Angelo's own original wax model of his superb David, looking even *more* majestic and imposing than the well-known gigantic statue on the Piazza del Gran Duca, which may be imputed to the fact of his having been stinted in the size of the block of marble. Besides this master-piece, the cupboard further contained two other wax models by Michael Angelo, one his Giorno, the other his Crepuscolo,—both of which are in the chapel called Cappello di Michel Angelo in the Church of St. Lorenzo. There were likewise in this same closet models in clay by Giovanni di Bologna; they are his first conceptions of his most celebrated groups and statues. Another in wax, by Baccio Bandinelli, besides another by an unknown hand. Then, at the bottom of all, under a thick veil of cobweb, I perceived a quantity of fragments, which appeared to me of surpassing beauty. I collected the pieces, and joined them together with boiling wax, thread, &c.; when, to my great delight, I found my fragments assumed the form of the torso and legs of a Satyr, which is one of the finest works of Art that can be imagined. The celebrated engraver Jesi and another artist chanced to call upon us, and both proclaimed the Satyr to be the work of Michael Angelo;—but *then*, we had no *proof* of such being the case. Now comes what I deem the marvellous part of the story. The following morning, I again occupied myself groping and poking about the gallery, particularly in an old cabinet or closet which they say Michael Angelo used to write in. At length, I pulled out a drawer, in which was a letter, dated 1660, from one Covr. Pansani, who begs the Proc. Buonarotti to accept a *Torso di Satiro*, the work of his great ancestor Michael Angelo.* * *—In this extraordinary manner have I obtained the proof of the authenticity of my *Satiro*."

DESIDERATA FOR THE MORE ADVANTAGEOUS STUDY OF MEDIÆVAL ARCHITECTURE.

Mr. Editor—In your August number I read the article on the "Future Development of Mediæval Architecture," with much interest and gratification, and no doubt very many of your other subscribers did the same, the good taste, the soundness of judgment, the freedom from all dogmatising or flippant treatment of opposite opinions, quite led me to anticipate from the paper a thorough knowledge of his subject in the author, and this the whole article fully sustained.

With a view to follow up the subject in a practical way, I will venture to put down a few thoughts that have for some time occurred to me, and which you may perhaps consider worthy of insertion in your valuable Journal. They relate to the necessity there still exists of some well digested compilation, to set forth the choicest examples of really good Mediæval architecture, both in the mass and combination, and also in the details. This may at first appear a startling assertion, when the number and vast variety of works already published and constantly issuing from the Press are considered, intended to bear upon that professed object.

So far as I am able to judge of any work I have yet seen, I think we have no grammar of the art, as it were, such as we have in all other studies, whereby the student may really begin at the right end as to what he has to learn, and arrive at the procurement of that elementary knowledge in the shortest possible time. I consider this latter, in their railway era, of real importance.

From the architectural student of the present day so much will be required, that whatever facilitates his path by enabling him promptly to acquire the mechanical, and helping him quickly to discover or to feel the beautiful, and as readily to repudiate the elaborated though expensive trifle, however ancient, will do much to help forward the future practitioner to a fuller attainment of the style in its highest excellence.

That much has been done within the last few years, to set up and induce the adoption of the style on a right foundation, must be admitted; and perhaps a condensation of, or a compilation from, existing publications might go far to accomplish what is wanted. Of books we have, I consider, far too many—that is, as to the good a student can derive from them; of those that profess to be initiatory, how much is there in the best of them of little or no avail for his purpose. We find a beauty of engraving—a costliness of drawing most engaging,—but there is in them all far too much beyond the energy or the attainments of a mere architectural student to expect him to work out; and, except the treat of frequently reviewing the plates and, perhaps, some general suggestions, he does not derive the help from the work which is most needed by him.

After much study of the architecture of the Middle Ages, I am satisfied the real practicable and imitative beauties for our adoption are confined to a much briefer epoch than many of its professors have been disposed to admit: and of these beauties—like all other truths or principles—the simplest, the most obvious, and least intricate of them, are those identical ones most capable of combination and expansiveness. Of the works issued by the several provincial societies, there are none that I have yet seen that will survive as conferring any abiding solid benefit on Pointed architecture; they all start from the same point, and none advance beyond a parallel degree or stage; indeed, it appears as though the pleasing illustration of the architecture of a district or archdeaconry was their only intention. Now this, from the nature of such associations may perhaps be essential to keep up an interest amongst subscribers; but I have long since thought that a portion of the funds at the command of these societies might be devoted to higher and more permanent advantages. Most of the elementary or instructive treatises that I am aware of have been undertaken as a trading matter, and as such they must necessarily combine as much for the money as possible, and they must further be made to suit the tastes of the greater number, and here appears to me to result their inadequacy. Without intending to disparage any work, it strikes me there needs in all of them a much sounder discrimination, to separate the precious from the vile; and, therefore, a society not publishing for profit could do what an individual publisher could not. In looking through even those works most recently issued, or in course of being so, I am surprised to find the omission of many choice examples infinitely more worth the drawing and engraving than some of the subjects given, and such examples, too, not at all inaccessible. Now, the collective knowledge of a society is likely to be able to gather a much more select assortment of specimens than an individual can be supposed to be aware of. I will repeat—what we want is far fewer, and far more select, subjects. The publishing of whole buildings cannot procure these, for in almost every structure there are many points which the student should be cautioned to avoid, as well as others he should be called upon to admire;—and therefore why publish faulty lessons instead of unexceptionable ones? Were the several societies moderately to contribute part of their funds to a delegated number of their respective bodies, some half dozen well qualified individuals might unite for the purpose of selecting examples wherever they were to be met with; to procure their accurate and detailed delineation, suitably figured; merely giving the place and where attainable, the date, and architect's or church builder's name, without encumbering the work with any topographical particulars, but giving, instead, the reasons for the excellency of the subject, the causes of beauty in the composition, or the feature. The examples need not be expensively engraved, but they should be drawn to a sufficiently large scale to be at once obvious and serviceable, as conveying their true portraiture, and to have a form and a substance imparted to them even more speakingly than is sometimes done in many of the exquisite examples of engraving frequently adopted in the present day.

The germ of the plan or method of selection is suggested by Pugin's lectures and Paley's moldings; but it ought not to be a sufficient recommendation that the examples be copied from an esteemed structure, or be of unquestionable antiquity; - its only recommendation should be its essential fitness and beauty; multiplicity of examples, except of the best character, should be most cautiously avoided.

After treating of details in their order, the work might proceed to give examples of combinations, still excluding or carefully repudiating every part not worth imitating,—and then at the conclusion, some examples of the massing of whole structures, which many of the Pointed buildings beautifully illustrate, and which Mr. Petit, in his work on Architectural Expression, has so happily developed from the very plainest structures. These might be accompanied with a few simple structures, showing why the effect of a certain mass is *rich*, and the effect of another *poor*.

The labour of the rising school of architects will have to be given to so many objects, that it will not do to direct the student to a choice example merely; but it must be to the very choicest of any two choice ones, that he may sieze the best first, and leave the second best, and go to something further,—that he may know more, day after day, how to weed his portfolio of questionable treasures in exchange for cardinal verities, and to give him time to digest these verities and get them thoroughly into him;—so that after a while he may trust to books less, and himself and his own correct principles more. The multiplication of books, as an architectural publisher admitted to me the other day, was the bane of the age, so far as the student was concerned.

On the basis of some such principles as these, Mr. Editor, do I consider Mediæval architecture should be studied;—to copy merely because the example is ancient, or because the original is associated with circumstances which can never be imparted to the imitation, is not to advance in architecture—but to retrogade.

If these remarks should lead to any practical good, I shall be glad; or should they suggest any hints to an inquiring and industrious architectural student, so as to show him what lies before him, I shall consider my time not mis-spent. I am, Mr. Editor,

One of your early Subscribers,

Nonnullus.

THE GAUGE COMMISSION.

Analysis of Evidence given before the Royal Commissioners appointed to investigate the subject of the diversity of Railway Gauges.

(*Continued from page* 214.)

George Parker Bidder, Esq.*: Is in the immediate management of the lines in Norfolk, and the Peterborough line. From his connexion with Mr. Stephenson, has more or less information of the lines with which he is connected. With respect to the great increase of cost which Mr. Gooch says exists upon the narrow gauge lines for the locomotive power of the goods trains, the cost upon the London and Birmingham and the Grand Junction being double what it is upon the Great Western, is prepared to dispute that fact entirely; but there are circumstances which might affect that comparison as to the particular character of the goods trade. On one line it may be necessary to have trains which may have to pick up goods at different stations, so as not to carry the same load from the terminus,

* The Editor has felt it his duty to append to this evidence some comments, which will be found in their proper places, inserted in brackets.

and at the same time to have the same engine power; and there may be a variety of other circumstances. For instance, on the Norfolk railway: at present the connection is not completed of the two railways at Norwich on account of a bridge of an original construction, a swing bridge; so that the fish is brought from Yarmouth to Norwich, then discharged, and carried across the river, then loaded again, and then brought to London, and those trucks go back light. Therefore, if you were to take the actual cost of the locomotive power for the goods there, you would have to charge two miles of locomotive power for one mile of effective traffic, and consequently, although the locomotive engines might be running at actually a less mileage than another line, yet in that sort of comparison, they might be made to appear to be working at a greater cost. Therefore, unless you have all the circumstances brought before you, any comparison of that nature appears to be not conclusive.

It does not appear that very much higher rates of speed would be required. There would be much more convenience from giving frequent departures, than from running particular trains at a very high velocity. And there is another question; after you have attained a speed of 40 or 45 miles an hour, the saving of time by the increase of speed does not go on *pro rata;* it is very much diminished. You save a great deal of time by an increase from 20 miles an hour to 40 miles an hour; but an increase from 40 to 50 miles an hour is not of that importance. With the present permanent way, where the rails are 70 to 75 lb. weight, you might travel certainly at 70 or 80 miles an hour.

The repairs are very much augmented by bad curves, and a wide carriage, or a wide engine, must be subject to greater torsion from curves than a narrow one. Cannot believe that it is possible that the repairs of the wide gauge carriage and engines can be so little as of the narrow. Has no experience of the repairs on the wide gauge, but on a bad curve line the repairs are very much augmented. On the Newcastle and Carlisle, the repairs of the engines, as compared with the North Shields, are about £250 per engine per annum.

Has a return of the performance of a goods engine in ordinary working on the Midland line between Derby and Rugby; and whether you take it as the actual weight moved or the evaporating power, it stands a favourable comparison with any engine referred to in the evidence of Mr. Gooch. In one trip the engine took from Rugby a gross load of 348 tons 16 cwt., to which you would have to add her own weight and that of her tender, about 35 or 36 tons. She took that load up 16 feet a-mile from Rugby, and she acquired a velocity for that 16 feet a-mile, of 15 miles per hour. If you compare that with a level line, it is equivalent to a gross load of very nearly 700 tons on a level. The quantity of water evaporated on that length was 35½ gallons per mile; that is equal to about 100 feet per hour. Now, from the experiments it appears, and it is consistent with one's notions, that the power of evaporation is directly, or nearly so, as the power of blast, that is, the number of strokes per minute, and the volume of that blast. From a return of an experiment on the Northern and Eastern, an engine which, at 30 miles an hour, evaporated not more than 70 or 80 feet per hour, evaporated 150 feet at 50 miles per hour.

[Mr. Bidder here assumes that the resistance to a train of 348 tons, on a gradient of 16 feet a-mile, is the same as that to a train of 700 tons on a level. The conclusion is independent of the velocity, and seems derived from taking the resistance of friction at 7 or 8 lb. per ton. This calculation omits the pressure on the blast pipe, which is a function of the velocity, and the resistance of the air, which is nearly as the square of the velocity, and depends, moreover, *not on the weight* of the train, but on the *surface* exposed to the action of the air. But setting all this aside, the amount of 7 or 8 lb. for friction is not even approximately correct, for it is certain that resistance from the unevenness of the rails, &c., is much greater at high than at low velocities. The idea that "the power of evaporation is directly or nearly as the power of the blast," is contradicted hereafter by Mr. Bidder's own figures. Besides, if this theory were true, *no* water at all would be evaporated when the engine was standing still, for then the blast is not in action.]

On the last experiment the train was reduced to 72 tons 12 cwt. gross, a little more than half the first load. The net speed realised was 43 miles per hour, and the quantity of water evaporated was at about the rate of 190 feet per hour. This engine was a long-tube engine; the tubes are 13 feet long, 15 inch cylinders, 22 inch stroke, 5 feet 6 inch wheels; the area of the fire-box is 49·786 feet, and the heating surface of the tubes 738 ft. Then the letter from which I take this goes on,—"To prove the temperature of the heat in the smoke box I suspended four pieces of metal, viz., one piece three parts tin and two parts lead, one piece one part tin and four parts lead, one piece lead, and one piece zinc, their melting points respectively being 334°, 470°, 590°, and 680°. These metals being suspended immediately above the top row of the tubes, about one inch from the tube plate. I found at the end of the journey that the three first-mentioned metals had melted, but the zinc did not melt in any of the three trips, proving the temperature of the heated air to be about 600°." Now that shows that the temperature of the steam in the boiler being about 312°, and the air, when escaping from the tubes, being about 600°, it is quite clear that every part of those tubes must have been available in heating the water, and in the evaporation of steam; and by a comparison, taking the different loads and comparing them with the experiments of the goods engines, which are of a similar construction, with the same area o fire-box, and the same tube surface, you will find, as nearly as can be, that the evaporating power is a function of velocity, and also the function of the area of the cylinder. This clearly shows that the long boiler not only increases the evaporating power, but increases the economy in the conversion of water into steam.

["This clearly shows" nothing of the kind. To get at anything like a trustworthy conclusion, the same experiment should have been made with a short-boiler engine, and the results compared. We are not told who made the experiments, or how they were made, and consequently do not know how far they deserve to be trusted. Our confidence, by the by, is not increased by reading that the fact the zinc did not melt proves "the temperature of the heated air to be about 600°": this makes well for Mr. Bidder's side of the question, but all that can be legitimately concluded is, simply, that the temperature was under 680°—it may have been 670°. The fact that the temperature of the air was about double that of the steam, shows that not nearly all the heat of the former was usefully applied. To economise the whole of it, the hot air must continue to act on the steam till it can impart no more heat to it—that is, till the temperature of both is the same. How can we tell, *a priori*, that if the experiment had been tried on a short engine, this result would not have been more nearly attained than with the long-boiler engine, especially if we are to conclude that "the evaporating power is a function of velocity and also the function of the area of the cylinder," and does not depend on the amount of heating surface. It is to be observed the words, "is a function of," are incorrectly used as synonomous with "is *proportional* to."]

"In those experiments are you well assured that there was no priming? —Yes, especially in the goods engine; because, if you take that particular experiment to which I have alluded, where she took 385 tons gross up 16 feet a-mile; if you take the area of the cylinders and see what quantity of steam must have passed through them in passing over that gradient, and see what was the volume of the steam at the requisite pressure to convey that train, you will find that the quantity of water is more than that which appears to have been consumed, which I attribute to the fact that they must have been using steam at rather a higher pressure than ordinary in the boiler.

"How did you ascertain the amount of evaporation; after the experiment was over, how did you ascertain the quantity of water?—They take the gauge of the tender, and the gauge in the boiler, and then they have the superficial area of the boiler at the different heights, and the area of the tender. It is ascertained with very great exactness, and great facility."

[Here Mr. Bidder assumes his proposition in order to prove it. He takes it for granted that there would be no priming, in order to show that there was none. First, with respect to the means of ascertaining the amount of evaporation: his method simply shows the quantity of water *got rid of*—not the amount converted into steam and usefully employed. The water *might* have passed away by leakage or priming,* or the steam might have escaped by the safety valve. But he is assured these contingencies could not have occurred, for he calculated the amount of work done, and the quantity of steam required to do it. He is certainly the first person who has been able to ascertain the resistance to a train with anything like the accuracy necessary for a calculation of this sort, and has increased the simplicity, if not the accuracy, of his operations by taking it for granted that 700 tons on a certain gradient are equivalent to 348 on a level. To find the quantity of water required to do the work, the recipe is to "take the area of the cylinders and see what quantity of steam passed through them," but who but Mr. Bidder could tell *a priori* how much that steam was dilated in coming from the boiler, and what was its precise effect when acting expansively—in other words, the exact nature of its mechanical action? Both problems are, considered separately, so intricate as to baffle all human ingenuity. The first, the resistance offered to the train depends on the wind, concussion at the joints of the rails, friction of the axles of the carriages, and other complicate mechanical actions, varying with every variation of velocity. The second, the mechanical effect of the steam it is equally impossible to predict. The relation of the power of the steam to the quantity of water used depends on the temperature and tension in the boiler and the temperature and tension in the cylinder; the latter varying not only at every stroke, but (when the steam is used expansively) at almost every part of the stroke. It is therefore quite impossible to take the two problems separately; they must be considered together, as De Pambour has considered them. We have quite sufficient proof, however, that Mr. Bidder's calculations were all wrong,

* De Pambour shows that of the whole quantity of water consumed, one-fourth is, on the average, wasted by being drawn into the cylinders in a liquid state. So much for there being no priming!

from his anomalous conclusion that *more* water was required than was actually expended! In accounting for this anomaly, he let us into a secret;—he confesses that he did not know the pressure in the boiler, which of course should have been an essential ingredient in his calculation.]

A law seems to exist that the power of producing steam is as the velocity, that is, the number of blasts and the volume in the cylinder; that is, as long as the fire-place will supply you with combustion to that amount; but as you increase the blast the combustion goes on in that ratio; and even with the Great Western experiments, and those taken with a short boiler, it is found almost invariably as the result, that 1 lb. of coke evaporates 7 lb. of water. With the long boiler we hardly ever get an effect of less than 8 lb. of water to 1 lb. of coke, and in some of these experiments it is as much as 10 lb. And we get economy in another way. In a comparison of engine power and of the consumption of coke, you may get a fallacy from not knowing to what extent there may be pilotage in one line or another. If an engine on one line has double the amount of engine piloting which there is on another, her consumption goes into the general mileage; whereas the consomption of coke while running may be very much less. On the Northern and Eastern, when that line was first opened to Broxbourne, their engines only consumed 20 lb. of coke while running, and yet the daily returns showed 36 lb.; that was from the quantity burnt at the stations. Now a long-boiler engine is economical in that respect, because, no doubt, from the length of tubes, the quantity evaporated while standing and the coke consumed is very much less; in fact, an engine with 13 feet tubes burns only half the coke standing that is consumed by an engine with 8 feet 6 tubes.

[In the first part of this paragraph the blast is supposed to increase the evaporation, but to also increase the consumption of coke *in the same ratio;* so that though more coke is burned in a hour, the effect of each pound of coke is not increased. In other words, the blast is supposed not to increase the *economy* in the use of the coke. Now, it has always hitherto been supposed that a strong current of air (and, therefore, of oxygen) rendered the combustion not only more rapid but more *perfect* also, and that where the supply of oxygen was insufficient, a great part of the fuel was wasted and passed away unconsumed, or without developing its evaporative power. It is, therefore, concluded that the rapidity of the current of air (within certain limits, of course,) increases the actual economy in the consumption of fuel. In the last sentence of the paragraph, the "quantity evaporated while standing" by a long-boiler engine is supposed to be less than by a short boiler engine; and yet the principal argument in favour of the long boilers has always been understood to be their increased amount of heating surface, which might be supposed to increase the quantity of water evaporated, whether the engine were standing or in motion.]

"Do you think any good would result from the use of corrugated metal for fire-boxes?—I do not think there would be any. They get apparently a larger surface; but I think the effect upon that surface must be weakened to the same extent as you happen to extend the gauge. With a certain amount of combustible matter in a pound of coke, if you get the whole of that out, which we do with a long-tube engine more effectually than they do with a shorter one, from the fact that we get 8 lb. of water evaporated instead of 7 lb., I do not see myself how you can do more than extract that matter and apply it usefully; it does not matter whether it is in the fire-box or in the tube."

[Mr. Bidder does not see any use in increasing the surface of the fire-box, because "you can do no more than extract the matter and apply it usefully." But, then, that is assuming that *all* the matter is applied usefully in the long-boiler engines; whereas, he himself has proved that this is not the case, from the fact that the temperature in the tubes is twice that of the steam.]

There is a great difference of opinion respecting the atmospheric resistance; the fact has come before me from the experiments not only with the locomotive engines but on the atmospheric railway, where I see the power that has been expended and the result, and I cannot account for the expenditure but by atmospheric resistance, or some resistance which is a function of the velocity. For instance, I take a locomotive engine, No. 6, on the Northern and Eastern. I put behind that engine a train of 100 tons, she will travel with that train at the pace of 30 miles an hour, and she will evaporate at the rate of 80 feet per hour. I reduce those 100 tons to 20, that engine goes at 50 miles an hour and evaporates at the rate of 150 feet per hour; and I find, as nearly as can be, that the same quantity of water is converted into steam per mile with the light train as with the heavy train, showing that the *pressure upon the piston is nearly the same*, and that the power has been absorbed by this great augmentation of resistance.

[The blunder marked by italics rivals the celebrated notion started in the investigation of the Norfolk railway accident (*ante* page 51), that an engine can be forced off the rails by the suddenly shutting off the steam. In the present case, Mr. Bidder evidently disregards the fact that the quantity of water drawn into the cylinder in a liquid state is much greater at high than at low velocities. Otherwise, how could he conclude that, because the same quantity of water was consumed during a slow as during a fast journey, the cylinder-pressure was the same in both cases? It is impossible to estimate the effective vaporisation by the water consumed; for even the mere circumstance of the boiler being fuller at one time than another will account for an enormous increase of priming. The inconsistency of this paragraph with that in which Mr. Bidder states that he is "well assured there was no priming" is also to be noted. *There* he was able to calculate the resistance to the train with the utmost exactness; all language of uncertainty was avoided,—we were told to "*see*" the resistance of a train in passing over a certain gradient, as if this *seeing* were the easiest process in the world. *Here*, however, the resistance is treated in quite a different manner—it is some very vague uncertain thing, which Mr. Bidder "cannot account for" but by supposing there is "some" force or another (he knows not what) functional of the velocity. *Here*, too, the resistance can only be ascertained from the vaporisation. *There* it could be calculated independently of the vaporisation—aye, and with that precision that the amount of priming could be deduced from the calculation. It is important to observe that at ordinary boiler pressures, steam occupies *from four to five hundred times* the space of the water from which it is produced. This shows how enormously the evaporation is exaggerated by neglecting the effect of priming.]

The following are extracts from Mr. Bidder's report on the results of the experiments tried with the broad and narrow gauge engines:—

"Before calling your attention to the facts shown in these experiments, which cannot be influenced by any circumstances, and which, in my opinion, are alone worthy of your notice, I will repeat that the object proposed was to ascertain the truth (and that alone) of statements which had respectively been made by Mr. Gooch and myself, as to the comparative power and economy of engines now in operation on the broad and narrow gauge lines, and more especially with respect to the importance of surface obtained by increasing the fire-box, or lengthening the tubes, and that any inference drawn from the results which shall bear on the merits of the two gauges will be foreign to the objects proposed, and false, as the circumstances of the experiments are not found to obtain in practice. Supposing, however, that they were, and that an increase of power were deemed desirable, I do not hesitate to say that that which is at present found ample for all purposes might be doubled, or more than doubled, on either gauge.* I shall now proceed to examine the evaporating power of the engines, as well as the relative economy of evaporation and efficient application of the steam evaporated. It will be recollected that on the part of the broad gauge, it was alleged (in reference to the statement that on the narrow gauge, not only economy but power was obtained by lengthening the boiler) that the area of the fire-box alone was the test of the power of the locomotive engine, and that 2 cubic feet of water per hour per superficial foot of fire-box have the capacity of evaporation of locomotive engines; and thus it was alleged, that the Great Western engines could evaporate nearly 200 cubic feet per hour, while the narrow gauge engines could only convert into steam 100 cubic feet, the comparative fire-box surfaces being as 97 feet to 50 feet. In order at once to test this principle, let us examine the facts shown in the experiments. By reference to the particulars of the experiment with 50 tons with engine A, on December 31st, 1845, between Darlington and York, a distance of 88½ miles, it will be found that the water evaporated is 20,520 lb., being at the rate of 232 lb. per mile. In the (up) journey the first mile, as well as the last 1½, were passed over slowly; as also were the first quarter and last mile on the return trip, in all 3¾ miles. In order, therefore, to get at the maximum average rate of evaporation on the trial, I take 20,250 lb., less 812 lb. (the water consumed in passing over the above 3¾ miles, at the rate of 232 lb. per mile), 19,700 lb., the weight of water evaporated by the engine in passing over the remaining 85 miles, which was effected in 106 minutes 12 seconds, being at the rate of 11,150 lb., 178 cubic feet per hour. I will now compare this with the experiment most resembling it in regard to the evaporation tried on the broad gauge. I take the experiment with 60 tons on December 17th. The total water evaporated was 24,640 lb. on 106 miles, or 232 lb. per mile; deducting from this 1,044 lb. for water due to 4½ miles passed over slowly, leaves 22,596 lb. of water evaporated in 112 minutes and 42 seconds, being at the rate of 11,820 lb., 189 cubic feet per hour, that is little more than the evaporation of the narrow gauge engine. When, however, we compare the coke, we find in the case of the broad gauge engine, that 7·8 lb. of water only were converted into steam by 1 lb. of coke, whilst the narrow gauge engine evaporated 9·6 lb., being a difference in regard to economy of fuel of 23 per cent. in favour of the narrow gauge engine."

* "In evidence given by Mr. Gooch, the average gross weight of passenger trains on some of the principal railways is given as follows:—

—	Great Western Railway.	Grand Junction Railway.	London and Birmingham Railway.	Birmingham and Gloster Railway.	South Western Railway.
Average gross weight in tons	67	43	42	38	36

The lightest of the trains included in the above average are express trains; there are now, therefore, engines in use on both gauges capable of taking trains of double the weight of those required in practice of the express speeds."

From the concluding sentence of this quotation, it is clear that Mr. Bidder's only test of the relative economy of the two engines is—not which does the greatest quantity of work for a given quantity of coke—but, which gets rid of the greatest quantity of water for a given quantity of coke: and, accordingly, he has drawn up a tabular account of the experiments, wherein, in the very cases in which the broad gauge engine evidently did the most work with a pound of coke, he concludes that because it did its work with a small quantity of water, *therefore* the engine was comparatively ineconomic! If the table were not actually printed and published, our readers might perhaps doubt whether we had fairly represented its contents. The following, however, is an exact copy:—

Experiments.	Engine.	Water evaporated per mile.	Coke consumed per mile.	Water evaporated per lb. of coke.	—
		lbs.	lbs.	lbs.	
No. 1 80 Tons.	Ixion ..	245	33·6	7·12	Broad gauge.
2 70 ,,	Ixion ..	238½	33·6	7·12	
3 60 ,,	Ixion ..	232	29·6	7· 8	
No. 1 50 Tons.	30th Dec., A.	291	31·2	9·3	Narrow gauge.
2 50 ,,	31st Dec., A.	232	24·	9·6	
3 80 ,,	31st Dec., A.	235·7	26·6	8·8	

The fifth column gives, according to Mr. Bidder's views, the figures by which the economy of the engines is to be tested. Let us take the first experiment in each case. In the narrow gauge experiment, No. 1, the train was 50 tons, and the consumption of coke 31·2 lb. per mile: in the broad gauge experiment the train was 80 tons, and the consumption of coke *not* 2½ lb. *more per mile*. It is obvious that the 2½ lb. will not alone account for the enormous difference between the two loads—namely 30 tons. The only conclusion which any rational unprejudiced man could draw would be that more work was got out of the coke in the one case than in the other. And this conclusion would be greatly confirmed by observing what Mr. Bidder omits mentioning, that the broad gauge train moved *fourteen miles an hour faster* than the narrow gauge train. And yet, because the water evaporated was less in one case than the other, we are provided with a fifth column of "water evaporated per lb. of coke," from which it is gravely inferred that the narrow gauge trip was performed the most economically! We must protest against this wholesale method of jumping at conclusions which shows a lamentable confusion of ideas respecting the mechanical action of steam

We said that Mr. Bidder's own figures contradicted his hypothesis that "the quantum of evaporation is a function of [*i. e.* is proportional to] the number of blasts per minute." Taking Nos. 1 and 3 of the broad gauge trips, which were respectively the slowest and fastest trips, the quantity of water in the first case was the *greatest* (viz., 245 lb.) and in the second the *least* (viz., 232 lb.). We get precisely the same result with the fastest and slowest of the narrow gauge journeys: so that if Mr. Bidder's table prove any relation of the evaporation to the blast at all, the conclusion must be the very reverse of his theory. It has been ascertained that if an engine be deprived of its blast pipe, the rate of evaporation will be reduced to about one-fifth; but from the few experiments instituted under this head, it would appear that under ordinary circumstances, when the blast is in action, its effect on the rate of evaporation varies as the fourth root of the velocity.

Before concluding these observations, we ought to offer some remarks on the particular circumstances under which the narrow gauge experiments were made. The following extracts from Mr. Gooch's report are not a little surprising "*The engine was on each occasion placed at Darlington over a powerful stationary blast for the purpose of getting very hot water in the tender and a bright fire to start with.*" By these means, the water in the tender was raised to 180°. In the experiments with goods trains, "*the engine was placed over the blast, and remained there an hour and a half. The tender containing warm water was taken from another engine and attached to the regular tender, and men were provided to bucket the water from one tender to another as the train was moving.*" Mr. Gooch plaintively observes that this contrivance would have been of great use in the broad gauge experiments.

The love of philosophical accuracy displayed by the conductors of the narrow gauge experiments precludes the supposition that *they* sanctioned these devices, which must therefore be attributed to the subordinate officers of the railway. But, at all events, they sufficiently account for the circumstance that the narrow gauge engines got rid of more water for each pound of coke (although they generally did less work for each pound of coke) than the broad gauge engines. It is, of course, more easy in the dead of winter to boil water previously raised to a temperature of 180° than water originally at the temperature of the atmosphere.

We must guard ourselves against the supposition that the experiments prove decisively the superiority of the broad gauge engines. In fact, they prove *nothing*. They were so few and so improperly conducted that no trustworthy conclusion can be derived from them. They ought to have been repeated several times over, under the superintendence of disinterested persons, whose object was—not to get up a series of showy results—but to exhibit, as nearly as possible, the *ordinary* working of either kind of engines. However, the observations here made will have, at least, one good effect: they will enable the reader to appreciate the philosophy given in evidence before public commissions on engineering questions, and to estimate the value of the experiments authoritatively sanctioned.

ON MASONRY.

(*From the Ecclesiologist.*)

The writer of this paper remembers an incident which puts in a rather striking light a very puzzling question about masonry, that must have often occurred to some or other of our readers. He had just been shown some of the famous quarries near Caen, by one of the proprietors; and having come out near a little Norman church, claimed his conductor's admiration for the effect of solid strength and lastingness which Romanesque ashlar, particularly when of Caen stone with the hoary grey of seven centuries upon it, always presents.* The answer was not what he expected. Instead of joining in his praises, his guide began to lament that the ancients could not do better, because they could not draw stones of any considerable size from the quarries. They had made good use, he allowed, of the small broken bits of stone they could dig out: but our mechanical advantages enabled us, with larger blocks, to adopt a more perfect kind of masonry. Now it is difficult to answer this. There is no doubt that some of the finest buildings of antiquity are constructed of stones of immense size. The Pantheon may be quoted for this; and every one will remember the huge blocks that must have been quarried for monolith columns. The general decline of art shows itself in this respect perhaps as well as others. There is a great gap between such a building as the Porta Nigra of Treves, and the best of early Romanesque masonry. Art in all its branches was, it seems, almost to die: in order perhaps that Christian Art might be less a development than a new creation. The Pharos in Dover castle is a fine specimen of Roman excellence: its builders could not get hewn stone; but they so bound their flint rubble with bands of brick, that the tower stands like a rock. Close by is the desecrated church with a good deal of undoubted British masonry in its shell. Here too, there is "Roman brick" in the quoins, &c.; but the general inferiority of the masonry to the real Roman work is very striking. Then, again, the fine Romanesque ashlar in the chapel of the Norman keep in the same fortress, is a specimen of the reviving art of masonry; but it is in kind like that of the little parish church near the Caen quarries.† The stones are all small, though beautifully and effectively used: there is no single stone to tempt you to measure its length and width, and to exclaim at its bulk: which seems to be the general effect produced on people's minds by modern masonry. As a matter of fact, it must, we suppose, be granted, that the architects of the Romanesque and Early-Pointed styles could not procure large stones: they were compelled to use even fine building stone, like that (which they so highly valued) of Normandy, in small masses, as they could inartificially obtain it from the quarries. So late as 1841 there was not a single crane at Caen, by which to ship the stone, had it been extracted in very large blocks,—a fact that may assist us to comprehend the great mechanical disadvantages under which the mediæval architects laboured. But though their stone was in such small pieces, how beautifully they used it! Of course, there is a great deal of ancient work that is very bad; although what has stood for six or seven centuries, may seem fairly entitled to entire exemption from any blame. But as a general rule, early masonry—at least after the later Romanesque had superseded the Anglo-Saxon kind—is surprisingly excellent: not only for solidity, but for keeping and harmony. It suits the style. The eye is satisfied entirely, without knowing or inquiring why. You admire the design, and feel almost unconsciously that it is worthily embodied in its material exhibition. You are neither induced to examine and commend the ingenuity with which the difficulties of a bad building stone are overcome, nor are you called on to join in the vulgar admiration of "such big blocks." In a word, you forget such a mere detail in the whole: but when you can descend from the whole into particulars, you find them all that can be wished.

There is so much that might be said about masonry, that we are unwilling to open the subject from a consciousness of our own ignorance. No

* This effect may be partly judged of from an examination of the drawings of Than church, in the elder Pugin's "Normandy."

† Not nearly enough attention has been paid to the subject of masonry, if only to determine dates. Let any one compare the excellent ashlar of this chapel, and the wretched rubble of St. Sepulchre's Cambridge, which is later in point of age; or even with the White Chapel in the Tower of London.

question more deserves study, and few are less attended to. The Cambridge Camden Society very early called attention in its church-schemes to the nature of masonry and jointing, but with small results. The nature of building stones, and the peculiar treatment of each, particularly as regards mouldings,—in granite for example, where from the hardness of the stone they are of necessity superficial, and in Kentish rag, where they are broad and coarse because the stone will scarcely take an edge,—are points for further investigation. At present, we propose only to make some general remarks, chiefly on the treatment of Kentish rag, which seem called for because this stone is coming happily into more frequent use in London.

In the beginning of the present revival of Church Architecture, the masonry, where brick was not used, was quite of the modern kind. Squared stones, as large as could be easily procured, were laid very neatly and closely, with as much regularity as was possible. This kind of masonry is by itself enough to spoil the effect of a Pointed building; as will be evident to any one comparing the new Pointed work at King's College, Cambridge, with the masonry of the chapel on the opposite side of the quadrangle. The same defect goes through all the modern Pointed work in Cambridge. It is curious to notice how truly small stones seem to be appropriate to the requisites of Pointed architecture. An arch is the skilful adjustment of stones not long enough to go across, so as to span over a space and support a weight. Hence a metallic development of architecture would probably reject the arch, because a strong metal bar may be of any length, and would be sufficiently strong for the top of almost any aperture. Whence it seems to be a gross unreality to cut a whole window-head, with arch and tracery, out of one block of stone large enough to cover the whole window opening. Yet this mockery has been resorted to in the New Houses of Parliament,—to mention a rather conspicuous instance. But without any reference to principles, few will doubt that, for whatever reason, the small masonry of ancient work is far more effective than the finest building on the modern plan with huge stones laid in regular courses. Some have thought that this difference arises from the fact that the smallness of parts gives increased scale to the whole; others, that from the regularity of courses in modern masonry there comes a too great preponderance of the horizontal lines in the building. But this question we cannot now discuss. Suffice it to say, that it is now becoming generally acknowledged that there is a great difference between Pointed and Classical masonry, and that the smaller size of the stones and the irregularity in laying them are main characteristics of the former style. But of the attempts to copy ancient masonry there are few which are not great failures. It was easily seen that the primness of modern quoining was not only tame and dull but utterly unlike old work; but it was not found so easy to remedy the fault. Builders began to try irregular quoining, and we soon saw prodigies of irregularity. On one side of the angle there would be three stones of different lengths running into the wall; then two running into it on the other side; then perhaps one, and again three, on no plan or principle whatever. The quoins became distressingly jagged; and after being pained one wonders why it need be so jagged. A more close observation of ancient work would enable us to detect some principle of order in its seeming irregularity. We believe that the very natural and reasonable alternation of long and short stones,—which is seen in its primitive simplicity in Anglo-Saxon masonry, of which indeed it is considered a great characteristic,—was always retained, though not in so harsh and cramped a form. The mason took long and short stones alternately, but was not careful to make them all tail into the wall of the same length, nor even to keep them of the same thickness.

Perhaps this is one great reason why brick quoins to a random wall are so particularly ugly, as brick can scarcely be used for quoins unless with the strictest uniformity.

So much for quoins. With respect to walling, the days are happily fast going when people were not satisfied without at least a scored stucco substitute for large ashlar. Architects are beginning to venture upon using local stones, rag and rubble. This is a very great change for the better in all respects.; and it is proportionately a matter of regret that these materials should not be rightly treated. For example, that useful stone, Kentish rag, has been already several times used in London; as at St. Michael's Chester-square, St. John, Charlotte street, and Christ Church, Broadway. No one can doubt that this is a great gain over brick or stucco: this ragstone being both very durable and of a good colour. It would also be an economical material if used as the ancient architects used it; but in these churches it is used in regular square blocks, producing no better effect than that of bricks of a new colour, and being very costly to boot. For no stone is less adapted for squaring than this, owing to its hardness and its decided grain. Any one who would visit the quarries near Maidstone and watch the process of squaring would be astonished at the waste. The small pile of squared material contrasts most strikingly with the huge heap of refuse stone, which, being rejected as unfit for building, is used merely for road-mending, for which purpose it is transported to great distances. And besides this waste, a good deal of labour has often been spent upon refuse stones, which, when nearly squared, have been shattered by some unlucky cross-grained blow. But to what purpose is this expensive squaring in a stone which seems only adapted for cleavage? In effect, a random wall, properly treated, is far better than one of squared blocks. All Saints, Maidstone, is built, we are aware, of squared rag; but it is squared in thinner layers than is now usual. St. Peter and St. Paul, Lingfield, is an example of the extremely bad appearance of very large and unwieldy masonry.* As for the expensiveness of this squaring process, the reader may judge when he is told that the stone may be drawn from the quarries in a natural way for half-a-crown a ton: the squared stone costs eight shillings and sixpence a ton. It really becomes a duty of church-builders to take care that their architects do not waste so much money in a process which is at best so unsuccessful and unsatisfactory.

There have been, however, several attempts, particularly in the neighbourhood of Maidstone, to use Kentish rag properly, that is, as irregular (or random) walling. But here again we have to find the same fault as with most modern attempts at irregular quoining. The irregularity is overstrained. There is not one stone at rest; not one seems to have a bed. They lie at all angles: some even stand on their points, merely propped by the contiguous stones. The masonry looks more like an intricate puzzle than anything else. Instead of this, in ancient random walling we may trace this principle,—always to lay every stone in its best bed, lifting up any part of it which may want thickening by means of thinner pieces. Regular courses are not studiously attempted; but any stone that comes to hand is laid in, provided it has a good plain bed.

These brief remarks must suffice, upon the use of Kentish rag more particularly, in quoining and walling. Many of them also apply however to other stones; for example, to the beautiful Bramley-Fall stone of Yorkshire, which is squared in the new church of St. Saviour, Leeds, for the walling as well as for the dressings.

As a general rule then we would give this advice to church-builders:—use the material of which the neighbouring churches are mostly built, and in the way in which they are built. If we study carefully the method of masonry employed formerly, we shall avoid both needless expense and eccentricity. For example, if flint is the material most easily procured, let us use flint; but only as it was used in old churches. We will not now enter on the nature of flint masonry, but would contrast only the absurd modern plan of using *black* mortar, from a fear of the wide joints in white, with the old way of "garretting" flint-work, that is, of inserting small flint-shivers in the mortar of the joints. But we purposely keep ourselves more particularly to the use of rag-stone; and upon this we may, in conclusion, remark that, without attempting to solve the general question started at the beginning of this paper, as to the supposed unreality of using small stones for masonry when we can get large ones, we may surely lay down that it is wrong and absurd to spend much money in squaring stones, the nature of which does not easily yield to the process, and which have lasted so well and with such good effect as used in random work by ancient builders. What we want for church-work is that the material should be good and substantial, and the best that we can afford. We do not object even to brick in a bad stone district, and where the funds are small. Only let the brick be honestly and intelligently used. On the other hand we see no objection to importing Caen stone for rich and stately churches in any district; though perhaps we shall rather rejoice than lament that the architects of Carlisle and Chester used the perishing red sandstone of their neighbourhood. For nothing can be more fitting than that we should press into the service of God whatever suitable materials His wonderful Creation may offer us. The very difference of material is a sign of the unity of the purpose to which they are consecrated, namely, His honour in His sanctuary. We would use flint, granite, sandstone, and ragstone, each in its proper district, in the spirit of the hymn, "Benedicat terra Dominum: Benedicite montes et colles Domino."

* All Saints, Maidstone, is built altogether in a very costly style, and has no pretension to random walling; the quoins and jambs are all in the same squared rag. The new churches we are criticising have their dressings in Caen stone, and the squared rag is used as if for random work. This is a great absurdity. One ought always to quoin with the strongest stone: if, therefore, one can afford to square so strong a stone as rag for the walling, it ought to be also used for the quoins. To use a soft stone like Caen for quoins to walling of a strong rag-stone is preposterous.

BRITISH ASSOCIATION.

Session 16*th*, *held at Southampton, September*, 1846.

Address of the President.

Sir R. MURCHISON, after complimenting the late President for his distinguished abilities and efficient services, addressed the association as follows:—

Ladies and Gentlemen,—After 15 years of migration to various cities and towns in the United Kingdom, you are for the first time assembled in the South-Eastern districts of England, at the solicitation of the authorities and inhabitants of Southampton. Easily accessible on all sides to the cultivators of science, this beautiful and flourishing sea-port is situated in a district so richly adorned by nature, so full of objects for scientific contemplation, that, supported as we are by new friends in England, and by old friends from the farthest regions of Europe, we shall indeed be wanting to ourselves, if our proceedings on this occasion should not sustain the high character which the British Association has hitherto maintained.

For my own part, though deeply conscious of my inferiority to my eminent predecessor in the higher branches of science, I still venture to hope that the devotion I have manifested to this Association from its origin to the present day, may be viewed by you as a guarantee for the zealous execution of my duties. Permit me then, gentlemen, to offer you my warmest acknowledgments for having placed me in this honourable position: and to assure you, that I value the approbation which it implies as the highest honour which could have been bestowed on me—an honour the more esteemed from its being conferred in a county endeared to me by family connexions, and in which I rejoice to have made my first essay as a geologist.

The origin, progress and objects of this our "Parliament of Science" have been so thoroughly explained on former occasions by your successive Presidents, particularly in reference to that portion of our body which cultivates the mathematical, chemical and mechanical sciences, that after briefly alluding to some of the chief results of by-gone years, with a view of impressing upon our new members the general advances we have made, I shall in this discourse dwell more particularly on the recent progress and present state of natural history, the department of knowledge with which my own pursuits have been most connected, whilst I shall also incidentally advert to some of the proceedings which are likely to occupy our attention during this meeting.

No sooner, gentlemen, had this association fully established its character as a legitimate representative of the science of the United Kingdom, and by the reports which it had published, the researches which it had instituted, and the other substantial services which it had rendered to science, had secured public respect, than it proceeded towards the fulfilment of the last of the great objects which a Brewster and a Harcourt contemplated at its foundation, by inviting the attention of the government to important national points of scientific interest. At the fourth meeting held in Edinburgh, the Association memorialised the government to increase the forces of the Ordnance Geographical Survey of Britain, and to extend speedily to Scotland the benefits which had been already applied by that admirable establishment to the south of England, Wales and Ireland. From that to the present it has not scrupled to call the notice of the Ministers of the day to every great scientific measure which seemed, after due consideration, likely to promote the interests or raise the character of the British nation. Guided in the choice of these applications by a committee selected from among its members, it has sedulously avoided the presentation of any request which did not rest on a rational basis, and our rulers, far from resisting such appeals, have uniformly and cordially acquiesced in them. Thus it was when, after paying large sums from our own funds for the reduction of large masses of astronomical observations, we represented to the government the necessity of enabling the Astronomer Royal to perform the same work on the observations of his predecessors, which had accumulated in the archives of Greenwich, our appeal was answered by arrangements for completing so important a public object at the public expense. Thus it was when contemplating the vast accession to pure science as well as to useful maritime knowledge, to be gained by the exploration of the South Polar regions, that we gave the first impulse to that project of the great Antarctic expedition, which, supported by the influence of the Royal Society and its noble President, obtained the full assent of the government, and led to results which, through the merits of Sir James Ross and his companions, have shed a bright lustre on our country, by copious additions to geography and natural history, and by affording numerous data for the development of the laws that regulate the magnetism of the earth.

The mention of "Terrestrial Magnetism" brings with it a crowd of recollections creditable to the British Association from the perspicuous manner in which every portion of fresh knowledge on this important subject has been stored up in our volumes, with a view to generalisation, by Colonel Sabine and others; whilst a wide field for its diffusion and combination has been secured by the congress held at our last meeting, at which some of the most distinguished foreign and British magneticians were assembled under the presidency of Sir John Herschell. It is indeed most satisfactory for us to know, that not only did all the recommendations of the Association on this subject which were presented to our government meet with a most favourable reception, but that in consequence of the representations made by Her Majesty's Secretary of State for Foreign Affairs to the public authorities of other countries which had previously taken part in the system of co-operative observation, the governments of Russia, Austria, Prussia, and Belgium, have notified their intention of continuing their respective magnetical and meteorological observations for another term of three years.

In passing by other instances in which public liberality has been directed to channels of knowledge which required opening out, I must not omit to notice the grant obtained from our gracious Sovereign, of the Royal Observatory at Kew, which, previously dismantled of its astronomical instruments, has been converted by us into a station for observations purely physical, and especially for those details of atmospheric phenomena which are so minute and numerous, and require such unremitting attention, that they imperiously call for separate establishments. In realising this principle, we can now refer British and foreign philosophers to the observatory of the British Association at Kew, where I have the authority of most adequate judges for saying they will find that a great amount of electrical and meteorological observation has been made, and a systematic inquiry into the intricate subject of atmospheric electricity carried out, by Mr. Ronalds, under the suggestions of Professor Wheatstone, to which no higher praise can be given than that it has, in fact, furnished the model of the processes conducted at the Royal Observatory at Greenwich. This establishment is besides so useful through the facilities which it offers for researches into the working of self-registering instruments which are there constructed, that I earnestly hope it may be sustained as heretofore by annual grants from our funds, particularly as it is accomplishing considerable results at very small cost.

Transactions of Vol. 1845.—*Physical Science.*

Our volume for the last year contains several communications on physical subjects from eminent foreign cultivators of science, whom we have the pleasure of reckoning amongst our corresponding members, and whose communications, according to the usage of the Association, have been printed entire amongst the reports. In a discussion of the peculiarities by which the great comet of 1843 was distinguished, Dr. Von Boguslawski of Breslau has taken the occasion to announce the probability, resting on calculations which will be published in Schumacher's "Astronomische Nachrichten," of the identity of this comet with several of a similar remarkable character recorded in history, commencing with the one described by Aristotle, which appeared in the year 371 before our era; should his calculations be considered to establish this fact, Dr. Von Boguslawski proposes that the comet should hereafter be distinguished by the name of "Aristotle's Comet." This communication contains also some highly ingenious and important considerations relating to the physical causes of the phenomena of the tails of comets.

Dr. Paul Erman of Berlin, father of the adventurous geographical explorer and magnetician, who was one of the active members of the magnetic congress at Cambridge, has communicated through his son some interesting experiments on the "electro-dynamic effects of the friction of conducting substances," and has pointed out the differences between these and normal thermo-electric effects. Baron Von Senftenberg (who is an admirable example of how much may be done by a liberal zeal for science combined with an independent fortune) has published an account of the success with which self-registering meteorological instruments have been established at his observatory at Seutenberg, as well as at the national observatory at Prague.

Of our own members, Mr. Birt has contributed a second report on "Atmospheric Waves," in continuation of the investigation which orginated in the discussion by Sir John Herschell, of the meteorological observations which, at his suggestion, were made in various parts of the globe, at the periods of the equinoxes and solstices, commencing with the year 1843.

In a communication to the meeting of the Association at York, Colonel Sabine traced with great clearness (from the hourly observations at Toronto) the effect of the single diurnal and single annual "Progressions of Temperature," in producing on the mixed vapours and gaseous elements of the atmosphere, the well-known progressions of daily and yearly barometrical pressure. To the conclusions which he then presented, and which apply, perhaps generally, to situations not greatly elevated in the interior of large tracts of land, the same author has added, in the last volume, a valuable explanation of the more complicated phenomena which happen at points where land and sea breezes, flowing with regularity, modify periodically and locally the constitution and pressure of the atmosphere. Taking for this data the two-hourly observations executed at the Observatory of Bombay by Dr. Buist, Colonel Sabine has succeeded in demonstrating for this locality "a double daily progression of gaseous pressure," in accordance with the flow and re-flow of the air from surfaces of land and water which are unequally affected by heat. And thus the diurnal variation of the daily pressure at a point within the tropics, and on the margin of the sea, is explained by the same reasoning which was suggested by facts observed in the interior of the vast continent of North America.

Among the many useful national objects which have been promoted by the physical researches of the British Association, there is one which calls for marked notice at this time, in the proposal of Mr. Robert Stephenson to carry "An iron tube or suspended tunnel over the Menai Straits" to sustain the great railway to Holyhead. This bold proposal could never have been realised, if that eminent engineer had not been acquainted with the great progress recently made in the knowledge of the strength of materials, and specially of iron; such knowledge being in great measure due to investigations in which the Association has taken and is still taking a conspicuous share, by the devotion of its friends and the employment of its influence—investigations which have been prosecuted with great zeal and success by its valued members, Mr. Hodgkinson and Mr. Fairbairn.

Whilst on this topic I may observe, that in the recent improvements in "Railways" the aid of scientific investigation was called for by the civil engineer, to assist him in determining with accuracy the power to be provided for attaining the "High Velocities" of fifty and sixty miles an hour; and it was found and admitted by the first engineers, that the very best data for this purpose, and indeed the only experiments of any practical value, were those which had been provided for some years ago by a Committee of the British Association, and published in our Transactions. The Institution of Civil Engineers thus gave testimony to the practical value of our researches by adopting their results.

However imperfect my knowledge of such subjects may be, I must also notice that the last volume of our Reports contains two contributions to experimental philosophy, in which subjects of the deepest theoretical and practical interest have been elucidated, at the request of the Association, by the labours of its foreign coadjutors.

That some substance of a peculiar kind everywhere exists, or is formed in the atmosphere by "Electrical Agency," both natural and artificial, had long been suspected, especially from the persistency of the odour developed by such agency, and its transference by contact to other matter. Professor Schonbein, to whom I shall hereafter advert as the author of a new practical discovery, is, however, the first philosopher who undertook to investigate the nature of that substance; and, though the investigation is not yet complete, he has been enabled to report no inconsiderable progress in this difficult and refined subject of research.

A request from the Association to Professor Bunsen, of Marburg, and our countryman, Dr. Lyon Playfair, coupled with a contribution of small amount towards the expenses involved in the undertaking, has produced a report "On the conditions and products of iron furnaces," which is of the greatest value in a commercial view to one of the most important of our manufactures, and possesses, at the same time, a very high interest to chemical science in some of the views which it develops. On the one hand, it exhibits an entirely new theory of the reduction, by cyanogen gas as the chief agent, of iron from the ore; on the other, it shows that, in addition to a vast saving of fuel, about two cwt. of sal-ammoniac may daily be collected at the single establishment of Alfreton, where the experiments were made; thus leadidg us to infer that in the iron furnaces of Britain there may be obtained from vapour which now passes away, an enormous quantity of this valuable substance, which would materially lessen the dependence of our agriculturists on foreign guano. It is, indeed, most gratifying to observe, that in pursuing this inquiry into the gaseous contents of a blazing furnace of great height, our associates traced out, foot by foot, the most recondite chemical processes, and described the fiery products with the same accuracy as if their researches had been made on the table of a laboratory. Weighed however only in the scales of absolute and immediate utility, the remarkable results of these skilful and elaborate experiments give them a character of national importance, and justly entitle the authors and the body which has aided them to the public thanks.

Natural History.

After this glance at the subjects of purely physical science treated of in the last volume of our Transactions, let us now consider the domains of natural history; and as one of the cultivators of a science which has derived its main support and most of its new and enlarged views from naturalists, let me express the obligation which geologists are under to this Association, for having aided so effectively in bringing forth the zoological researches of Owen, Agassis, and Edward Forbes. These three distinguished men have themselves announced, that in default of its countenance and assistance, they would not have undertaken, and never could have completed, some of their most important inquiries. Agassiz, for example, had not otherwise the means of comparing the ichthyolites of the British Isles with those of the Continent of Europe. Without this impulse, Owen would not have applied his profound knowledge of comparative anatomy to British fossil saurians; and Edward Forbes might never have been the explorer of the depths of the Ægean, nor have revealed many hitherto unknown laws of submarine life, if his wishes and suggestions had not met with the warm support of this body, and been supported by its strongest recommendations to the naval authorities.

These allusions to naturalists, whose works have afforded the firmest supports to geology, might lead me to dilate at length on the recent progress of this science, but as the subject has been copiously treated at successive anniversaries of the Geological Society of London, and has had its recent advances so clearly enunciated by the actual President of that body, who now presides over our Geological Section, I shall restrain my "esprit de corps" whilst I advert to some of the prominent advances which geologists have made. When our associate Conybeare reported to us, at our second meeting, on the actual state and ulterior prospects of what he well termed the "archæology of the globe," he dwelt with justice on the numerous researches in different countries which had clearly established the history of a descent, as it were, into the bowels of the earth—which led us, in a word, downwards through those newer deposits that connect high antiquity with our own period, into those strata which support our great British coal-fields. Beyond this, however, the perspective was dark and doubtful—

"Res altâ terrâ et caligine mersas."

Now, however, we have dispersed this gloom, and by researches first carried out to a distinct classification in the British Isles, and thence extended to Russia and America, geologists have shown that the records of succession, as indicated by the entombment of fossil animals, are as well developed in these very ancient or palæozoic strata as in any of the overlying or more recently formed deposits. After toiling many years in this department of the science, in conjunction with Sedgwick, Lonsdale, De Verneuil, Keyserling, and we have reached the very genesis of animal life upon the globe, and that no further "vestigia retrorsum" will be found beneath that protozoic or Lower Silurian group in the great inferior mass of which no vertebrated animal has yet been detected, amid the countless profusion of the lower orders of marine animals entombed in it. But however this may be, it is certain that in the last few years all Central and Eastern Europe, and even parts of Siberia, have been brought into accordance with British strata. France has been accurately classified and illustrated by the splendid map of Elie de Beaumont and Dufrenoy; and whilst, by the labours of Deshayes and others, its tertiary fossils have been copiously described, the organic remains of its secondary strata are now undergoing a complete analysis in the beautiful work of M. Alcide d'Orbigny. Belgium, whose mineral structure and geological outlines have been delineated by D'Omalius, d'Halloy and Dumont, has produced very perfect monographs of its palæozoic and tertiary fossils, the first in the work of M. de Koningk, the second in the recently published monograph of M. Nyst. Germany, led on by Von Buch, has shown that she can now as materially strengthen the zoological and botanical groundworks of the science, as in the days of Werner she was eminent in laying those mineralogical foundations which have been brought so near to perfection by the labours of several living men. So numerous in fact have been the contributions of German geologists, that I cannot permit myself to specify the names of individuals in a country which boasts so many who are treading closely in the steps of an Ehrenberg and a Rosè. As distinctly connected, however, with the objects of this meeting, I must be permitted to state that the eminent botanist Gœppert, whose works, in combination with those of Adolphe Brongniart in France, have shed so much light on fossil plants, has just sent to me, for communication to our Geological Section, the results of his latest inquiries into the formation of the coal of Silesia—results which will be the more interesting to Dr. Buckland and the geologists of England, because they are founded on data equally new and original. Italy has also to a great extent been presented to us in its true general geological facies, through the labours of Sismonda, Marmora, Pareto, and others; whilst our kinsmen of the far West have so ably developed the structure of their respective States, that our countrymen Lyell has informed us, that the excellent map which accompanies his work upon North America is simply the grouping together of data prepared by native State geologists, which he has paralleled with our well-known British types.

If then the astronomer has, to a vast extent, expounded the mechanism of the heavens; if lately, through the great telescope of our associate the Earl of Rosse, he has assigned a fixity and order to bodies which were previously viewed as mere nebulæ floating in space, and has also inferred that the surface-cavities in our nearest neighbour of the planetary system are analogous to the volcanic apertures and depressions of the earth; the geologist, contributing data of another order to the great storehouse of natural knowledge, has determined, by absolute and tangible proofs, the precise manner in which our planet has been successively enveloped in divers cerements, each teeming with peculiar forms of distinct life, and has marked the revolutions which have interfered with these successive creations, from the earliest dawn of living things to the limits of the historic æra. In short, the fundamental steps gained in geology, since the early days of the British Association, are so remarkable and so numerous, that the time has now come for a second report upon the progress of this science, which may I trust be prepared for an approaching, if not for the next meeting.

Intimately connected with these broad views of the progress of geology is the appearance of the first volume of a national work by Sir Henry De la Beche and his associates in the "Geological Survey of Great Britain." Following, as it does, upon the issue of numerous detailed coloured maps and sections, which for beauty of execution and exactness of detail are unrivalled, I would specially direct your attention to this new volume as affording the clearest evidence that geology is now strictly brought within the pale of the fixed sciences. In it are found graphic descriptions of the strata in the south-west of England and South Wales, whose breadth and length are accurately measured, whose mineral changes are chemically analysed, and whose imbedded remains are compared and determined by competent palæontologists. The very statistics of the science are thus laid open, theory is made rigourously to depend on facts, and the processes and produce of foreign mines are compared with those of Britain.

When we know how intimately the Director-General of this survey and his associates have been connected with the meetings of the British Association, and how they have freely discussed with us many parts of their researches—when we recollect that the geologist of Yorkshire, our invaluable Assistant General Secretary, around whom all our arrangements since our origin have turned, and to whom so much of our success is due, occupies his fitting place among these worthies—that Edward Forbes, who passed as it were from this association to the Ægean, is the palæontologist of this survey; and again when we reflect, that if this association had not repaired to Glasgow, and there discovered the merits of the survey of the Isle of Arran by Mr. Ramsay, that young geologist would never have become a valuable contributor to the volume under consideration—it is obvious from these statements alone, that the annual visits of our body to different parts of the empire, by bringing together kindred spirits, and in testing the natural capacity of individuals, do most effectually advance science and benefit the British community. Whilst considering these labours of the government geologists, I shall now specially speak of those of Professor E. Forbes in the same volume, because he here makes himself doubly welcome, by bringing to us as it were upon the spot the living specimens of submarine creatures, which through the praiseworthy enthusiasm of Mr. McAndrew, one of our members, who fitted out a large yacht for natural-history researches, have been dredged up this summer by these naturalists from the southern coast, between Land's End and Southampton. As a favourite yachting port like Southampton may, it is hoped, afford imitators, I point out with pleasure the liberal example of Mr. McAndrew, who not professing to describe the specimens he collects, has on this, as on former occasions, placed them in the hands of the members best qualified to do them justice, and is thus a substantial promoter of science.

The memoir of Edward Forbes in the Government Geological Survey is, in truth, an extension of his views respecting the causes of the present distribution of plants and animals in the British Isles, first made known at the last meeting of the British Association. As this author has not only shown the application of these ideas to the researches of the British Geological Survey, but also to the distribution of animals and plants over the whole earth, it is evident that these views, in great part original, will introduce a new class of inquiries into natural history, which will link it on more closely than ever to geology and geography. In short, this paper may be viewed as the first attempt to explain the causes of the zoological and botanical features of any region anciently in connexion. Among the new points which it contains, I will now only mention that it very ingeniously (and I think most satisfactorily) explains the origin of the peculiar features of the botany of Britain—the theory of the origin of Alpine Floras distributed far apart—the peculiarity of the zoology of Ireland as compared with that of England—the presence of the same species of marine animals on the coasts of America and Europe—the specialities of the marine zoology of the British seas called for by this Association—the past and present distribution of the great Mediterranean Flora;—and, lastly, it applies the knowledge we possess of the distribution of plants to the elucidation of the superficial detritus, termed by geologists, the "Northern Drift."

Amid the numerous subjects for reflection which the perusal of this memoir occasions, I must now restrict myself to two brief comments. First, to express my belief that even Humboldt himself, who has written so much and so admirably on Alpine Floras, will admit that our associate's explanation of the origin of identity removes a great stumbling-block from the path of botanical geographers. Secondly, having myself for some years endeavoured to show that the Alpine glacialists had erroneously applied their views, as founded on terrestrial phenomena, to large regions of Northern Europe, which must have been under the sea during the distribution of erratic blocks, gravel, and boulders, I cannot but consider it a strong confirmation of that opinion when I find so sound a naturalist as Edward Forbes sustaining the same view by perfectly independent inferences concerning the migration of plants to isolated centres, and by a studious examination and comparison of all the sea shells associated with these transported materials. And if I mistake not, my friend Mr. Lyell will find in both the above points, strong evidences in support of his ingenious climatical theories. Recent as the blocks and boulders to which I have alluded, may seem to be, they were however accumulated under a glacial sea, whose bottom was first raised to produce that connexion between the Continent and Britain, by which the land animals migrated from their parent East to our western climes; a connexion that was afterwards broken through by the separation of our islands, and by the isolation in each of them of those terrestrial races which had been propagated to it. This latter inference was also indeed thoroughly sustained by the researches of Professor Owen, communicated to this Association: first, in the generalisation by which his report on the extinct mammals of Australia is terminated, and still more in detailed reference to our islands in his recently published work "On the Extinct Fossil British Mammalia"—a work which he has stated in his dedication originated at the call of the British Association. Professor Owen adds, indeed, greatly to the strength of our present meeting, by acting as the president of one of our sections, which having in its origin been exclusively occupied in the study of medicine, is now more peculiarly devoted to the cultivation of physiology. Under such a leader, I have a right to anticipate that this remodelled section will exhibit evidences of fresh vigour, and will clearly define the vast progress that has been made in general and comparative anatomy since the days of Hunter and of Cuvier, for so large a part of which we are indebted to our eminent associate.

Assembled in a county which has the good fortune to have been illustrated by the attractive and pleasing history of the naturalist of Selborne, I am confident that our fourth section, to whose labours I would now specially advert, will yield a rich harvest, the more so as it is presided over by that great zoologist who has enriched the adjacent Museum of the Naval Hospital at Haslar with so many animals from various parts of the world, and has so arranged them to as to render them objects well worthy of your notice. The report of Sir John Richardson in the last volume, on the Fishes of China, Japan, and New Zealand, when coupled with his account in former volumes of the Fauna of North America, may be regarded as having completely remodelled our knowledge of the geographical distribution of fishes; first by affording the data, and next by explaining the causes through which a community of ichthyological characters is in some regions widely spread, and in others restricted to limited areas. We now know, that just as the lofty mountain is the barrier which separates different animals and plants, as well as peculiar varieties of man, so the deepest seas are limits which peremptorily check the wide diffusion of certain genera and species of fishes; whilst the interspersion of numerous islands, and still more the continuance of lands throughout an ocean, ensures the distribution of similar forms over many degrees of latitude and longitude.

The general study, indeed, both of zoology and botany, has been singularly advanced by the labours of the Section of Natural History. I cannot have acted for many years as your General Secretary, without observing, that by the spirit in which this section has of late years been conducted, British naturalists have annually become more philosophical, and have given to their inquiries a more physiological character, and have more and more studied the higher questions of structure, laws, and distribution. This cheering result has mainly arisen from the personal intimacy brought about among various individuals, who, living at great distances from each other, were previously never congregated; and from the mutual encouragement imparted by their interchange of views and their comparisons of specimens. Many active British naturalists have in fact risen up since these meetings commenced, and many (in addition to the examples already alluded to) have pursued their science directly under the encouragement we have given them. The combination of the enthusiastic and philosophic spirit thus engendered among the naturalists has given popularity to their department of science, and this section, assuming an importance to which during our earliest meetings it could show comparatively slender claims, has vigourously revived the study of natural history, and among other proofs of it, has given rise to that excellent publishing body, the Ray Society, which holds its anniversary during our sittings. Any analysis of the numerous original and valuable reports and memoirs on botanical and zoological subjects which have enriched our volumes is forbidden by the limits of this address, but I cannot omit to advert to the extensive success of Mr. H. Strickland's report on Zoological Nomenclature, which has been adopted and circulated by the naturalists of France, Germany and America, and also by those of Italy headed by the Prince of Canino. In each of these countries the code drawn up by the Association has been warmly welcomed, and through it we may look forward to the great advantage being gained, of the ultimate adoption of an uniform zoological nomenclature all over the globe.

Whilst investigations into the geographical distribution of animals and plants have occupied a large share of the attention of our Browns and our Darwins, it is pleasing to see that some of our members, chiefly connected with physical researches, are now bringing these data of natural history to bear upon climatology and physical geography. A committee of our naturalists, to whom the subject was referred, has published in our last volume an excellent series of instructions for the observation of the periodical phenomena of animals and plants, prepared by our foreign associate M. Quetelet, the Astronomer Royal of Belgium. Naturalists have long been collecting observations on the effects produced by the annual return of the seasons, but their various natural history calendars being local, required comparison and concentration, as originally suggested by Linnæus. This has now for the first time been executed by the Belgian Astronomer, who followed out a plan suggested by himself at our Plymouth meeting, has brought together the contributions and suggestions of the naturalists of his own country. When M. Quetelet remarks, "that the phases of the smallest insect are bound up with the phases of the plant that nourishes it; that plant itself being in its gradual development the product, in some sort, of all anterior modifications of the soil and atmosphere," he compels the admission, that the study which should embrace all periodical phenomena, both diurnal and annual, would of itself form a science as extended as instructive.

Referring you to M. Quetelet's report for an explanation of the dependence of the vegetable and animal kingdoms on the meteorology and physics of the globe, and hoping that the simultaneous observations he inculcates will be followed up in Britain, I am glad to be able to announce, that the outline of a memoir on physical geography was some months ago put into my hands by Mr. Cooley, which in a great degree coinciding with the system of M. Quetelet, has ultimately a very different object. M. Quetelet chiefly aims at investigating the dependence of organised bodies on inorganised matter, by observing the periodical phenomena of the former. Mr. Cooley seeks to obtain an acquaintance with the same phenomena for the sake of learning and registering comparative climate as an element of scientific agriculture. Speaking to you in a county which is so mainly dependent on the produce of the soil, I cannot have a more favourable opportunity for inculcating the value of the suggestions of this British geographer. The complete establishment of all the data of physical geography throughout the British Islands; i. e. the registration of the mean and extremes of the temperature of the air and of the earth; the amount of conduction, radiation, moisture, and magnetism; the succession of various phases of vegetation, &c. (with their several local corrections for elevation and aspect), must certainly prove conducive to the interests of science, and are likely to promote some material interests of our country.

A minute knowledge of all the circumstances of climate cannot but be of importance to those whose industry only succeeds through the co-operation of nature, and it may therefore be inferred that such a report as that with which I trust Mr. Cooley will favour us, if followed up by full and complete tables, will prove to be a most useful public document. Imbibing the ardour of that author, I might almost hope that such researches in physical geography may enable us to define, in the language of the poet,

"Et quid quæque ferat regio, et quid quæque recuset."

At all events, such a report will tend to raise physical geography in Britain towards the level it has attained in Prussia under the ægis of Humboldt and Ritter, and by the beautiful maps of Berghaus.

Though our countryman, Mr. Keith Johnston, is reproducing, in attractive forms, the comparative maps of the last-mentioned Prussian author, much indeed still remains to be done in Britain, to place the study of physical geography on a basis worthy of this great exploring and colonising nation; and as one of the highly useful elementary aids to the training of the youthful mind to acquire a right perception of the science, I commend the spirited project of a French geographer, M. Guerin, to establish in London, a geoarma of vast size which shall teach by strong external relief, the objects and details of which he will in the course of this week explain to the geographers present.

Reverting to economical views and the improvement of lands, I would remind our agricultural members, that as their great practical Society was founded on the model of the British Association, we hope they will always come to our Sections for the solution of any questions relating to their pursuits to which can be given a purely scientific answer. If they ask for the explanation of the dependence of vegetation upon subsoil or soil, our geologists and botanists are ready to reply to them. Is it a query on the comparison of the relative value of instruments destined to economise labour, the mechanicians now present are capable of answering it. And if, above all, they ask us to solve their doubts respecting the qualities of soils and the results of their mixtures, or the effects of various manures upon them, our chemists are at hand. One department of our Institution is in fact styled the Section of Chemistry and Mineralogy, with their applications to Agriculture and the Arts, and is officered in part by the very men, Johnston, Daubeny, and Playfair, to whom the agriculturists have in nearly all cases appealed. The first mentioned of these was one of our earliest friends and founders; the second had the merit of standing by the British Association at its first meeting, and there inviting us to repair to that great University where he is so much respected, and where he is now steadily determining, by elaborate experiments, the dependence of many species of plants on soils, air, and stimulus; whilst the third has already been alluded to as one of our best contributors.

If in reviewing our previous labours I have endeavoured to gain your attention by some incidental allusions to our present proceedings, I have yet to assure you, that the memoirs communicated to our secretaries are sufficiently numerous to occupy our sections during the ensuing week with all the vigour which has marked our opening day. Among the topics to which our assembling at Southampton gives peculiar interest, I may still say that if foreign and English geologists should find much to interest them in the Isle of Wight, the same island contains a field for a very curious joint discussion between the mathematicians and the geologists, with which I became acquainted in a previous visit to this place. It is a discovery by Colonel Colby, the Director of the Trigonometrical Survey, of the existence of a considerable attraction of the plumb-line to the south, at the trigonometrical station called Dunnose, on Shanklin Down. The details of this singular phenomenon, which has been verified by numerous observations with the best zenith sectors, will be laid before the Sections. In the meantime, we may well wonder that this low chalk range in the Isle of Wight should attract, in one parallel at least, with more than half the intensity of the high and crystalline mountain of Schehallion in the Highlands of Scotland, whilst no other chalk hill in the South of England exhibits such a phenomenon. Can those of our associates, who like Mr. Hopkins have entered the rich field of geological dynamics, explain this remarkable fact, either by the peculiar structure and distribution of the ridge of upheaved strata which runs as a back-bone from east to west through the island, or by referring it to dense plutonic masses of rock ranging beneath the surface along the line of displacement of the deposits?

The Southampton Well.

Another local subject—one indeed of positive practical interest—that stands before us for discussion is, whether, by persevering in deepening the large shaft which they have sunk so deep into the chalk near this town, the inhabitants of Southampton may expect to be eventually repaid, like those of Paris, by a full supply of subterranean water, which shall rise to the surface of the low plateau on which the work has undertaken? On no occasion, I must observe, could this town be furnished with a greater number of willing counsellers of divers nations whose opinions will, it is hoped, be adequately valued by the city authorities. The question whether this work ought to be proceeded with or not, will however, I apprehend, be most effectively answered by those geologists who are best acquainted with the sections in the interior of this country, and with the levels at which the upper greensand and subcretaceous strata there crop out and receive the waters, which then flow southwards beneath the whole body of chalk of the hills in the south of Hampshire.

Naval Architecture.

Considering that we are now assembled in the neighbourhood of our great naval arsenal—that some of its functionaries, including the Admiral on the station, have honoured us with their support, and that, further, I am now speaking in a town whose magnificent new docks may compete with any for bold and successful engineering, I must say a few words on our naval architecture, the more so as we have here a very strong Mechanical Section, presided over by that ingenious mechanician Professor Willis, supported by that great dynamical philosopher and astronomer Dr. Robinson. Duly impressed with the vast national importance of this subject, and at the same time of its necessary dependence on mathematical principles, the British Association in its earliest days endeavoured to rouse attention to the state of ship-building in England, and to the history of its progress in France and other countries, through a memoir by the late Mr. G. Harvey. It was then contended, that notwithstanding the extreme perfection to which the internal mechanism of vessels had been brought, their external forms or lines, on which their sailing so much depends, were deficient as to adjustment by mathematical theory. Our associate Mr. Scott Russell has, as you know, ably developed this view. Experimenting upon the resistance of water, and ascertaining with precision the forms of vessels which would pass through it with the least resistance, and consequently with the greatest velocity, he has contributed a most valuable series of memoirs, accompanied by a great number of diagrams, to illustrate his opinions and to show the dependence of naval architecture on certain mathematical lines. Employed in the meantime by merchants on their own account, to plan the construction of sailing ships and steamers, Mr. Scott Russell has been so successful in combining theory with practice, that we must feel satisfied in having at different meetings helped him onwards by several money grants; our only regret being that our means should not have permitted us to publish the whole number of diagrams of the lines prepared by this ingenious author.

But however desirous to promote knowledge on this point, the men of science are far from wishing not to pay every deference to the skilful artificers of our wooden bulwarks, on account of their experience and practical acquaintance with subjects they have so long and so successfully handled. We are indeed fully aware that the naval architects of the government, who construct vessels carrying a great weight of metal, and requiring much solidity and capacious stowage, have to solve many problems with which the owners of trading vessels or packets have little concern. All that we can wish for is, that our naval arsenals should contain schools or public boards of ship-building, in which there might be collected all the "constants of the art," in reference to capacity, displacement, stowage, velocity, pitching and rolling, masting, the effect of sails, and the resistance of fluids. Having ourselves expended contributions to an extent which testify, at all events, our zeal in this matter, we are, I think, entitled to express a hope, that the data derived from practice by our eminent navigators may be effectively combined with the indications of sound theory prepared by approved cultivators of mathematical and mechanical science.

Statistics.

I cannot thus touch upon such useful subjects without saying, that our Statistical Section has been so well conducted by its former presidents, that its subjects, liable at all times to be diverted into moral considerations, and thence into politics, have been invariably restricted to the branch of the science which deals in facts and numbers: and as no one individual has contributed more to the storehouse of such valuable knowledge than Mr. George Porter (as evidenced even by his report in our last volume), so may we believe that in this town with which he is intimately connected, he will contribute to raise still higher the claims of the section, over which he is so well qualified to preside.

If in this discourse I have referred more largely to those branches of science which pertain to the general division of natural history, in which alone I can venture to judge of the progress which others are making, let me however say, that no member of this body can appreciate more highly than I do, the claims of the mathematical and experimental parts of philosophy, in which my friend Professor Baden Powell, who supports me on this occasion as a Vice-President, has taken so distinguished a part. No one has witnessed with greater satisfaction the attendance at our former meetings of men from all parts of Europe the most eminent in these high pursuits. No one can more glory in having been an officer of this Association when it was honoured with the presence of its illustrious correspondent Bessel, than whom the world has never produced a more profound astronomer. If among his numerous splendid discoveries he furnished astronomers with what they had so long and so ardently desired—a fixed and ascertained point in the immensity of space, beyond the limits of our own sidereal system, it is to Bessel, as I am assured by a contemporary worthy of him, that Englishmen owe a debt of gratitude for his elaborate discussion of the observations of their immortal Bradley, which, in his hands, became the base of modern astronomy.

Foreign Contributors.

Passing from this recollection, so proud yet so mournful to us all as friends and admirers of the deceased Prussian astronomer, can any one see with more delight than myself the brilliant concurrence at our present meeting of naturalists, geologists, physiologists, ethnologists, and statists, with mathematicians, astronomers, mechanicians, and experimental philosophers in physics and in chemistry? Surely, then, I may be allowed to signalise a particular ground of gratification among so many, in the presence at this meeting of two individuals in our experimental sections, to one of whom, our eminent foreign associate, Oersted, we owe the first great link between electric and magnetic phenomena, by showing the magnetic properties of the galvanic current; whilst the other, our own Faraday, among other new and great truths which have raised the character of English science throughout the world, obtained the converse proof by evoking electricity out of magnets. And if it be not given to the geologist whom you have honoured with this chair, to explain how such arcana have been revealed, still as a worshipper in the outer portico of the temple of physical science, he may be permitted to picture to himself the delight which the Danish philosopher must have felt when, on returning to our shores, after an absence of a quarter of a century, he found that the grand train of discovery of which he is the progenitor, had just received its crowning accession in England from his former disciple, who, through a long and brilliant series of investigations peculiarly his own, has shown that magnetic or dia-magnetic forces are distributed throughout all nature.

And thus shall we continue to be a true British Association, with cosmopolite connexions, so long as we have among us eminent men to attract such foreign contemporaries to our shores. If then at the last assembly we experienced the good effects which flowed from a concentration of profound mathematicians and magneticians, drawn together from different European kingdoms—if then also the man (Mr. Everett) of solid learning, who then represented the United States of America, and who is now worthily presiding over the Cambridge University of his native soil, spoke to us with chastened eloquence of the benefits our institution was conferring on mankind; let us rejoice that this meeting is honoured by the presence of foreign philosophers as distinguished as those of any former year.

Let us rejoice that we have now among us men of science from Denmark, Sweden, Russia, Prussia, Switzerland, Belgium, Italy, and France. The King of Denmark, himself personally distinguished for his acquaintance with several branches of natural history, and a warm patron of science, has honoured us by sending hither, not only the great discoverer Oersted, who evincing fresh vigour in his mature age, brings with him new communications on physical science, but also my valued friend, the able geologist and chemist Forchhammer, who has produced the first geological map of Denmark, and who has presented to us a lucid memoir on the influence exercised by marine plants on the formation of ancient crystalline rocks, on the present sea, and on agriculture.

As these eminent men of the north received me as the General Secretary of the British Association with their wonted cordiality at the last Scandinavian Assembly, I trust we may convince them, that the sentiment is reciprocal, and that Englishmen are nearly akin to them in the virtues of friendship and hospitality which so distinguish the dwellers within the circle of Odin.

Still adverting to Scandinavia, we see here a deputy from the country of Linnæus in the person of Professor Svanberg, a successful young experimenter in physics, who represents his great master, Berzelius—that profound chemist and leader of the science of the North of Europe, who established on a firm basis the laws of atomic weights and definite proportions, and who has personally assured me, that if our meeting had not been fixed in the month of September, when the agriculturists of Sweden assemble at Stockholm, he would assuredly have repaired to us. And if the same cause has prevented Nilsson from coming hither, and has abstracted Retzius from us (who was till within these few days in England), I cannot mention these distinguished men, who earnestly desired to be present, without expressing the hope that the memoirs they communicate to us may give such additional support to our British ethnologists as will enable this new branch of science, which investigates the origin of races and languages, to take the prominent place in our assemblies to which it is justly entitled.

The Royal Academy of Berlin, whose deputies on former occasions have been an Ehrenberg, a Buch, and an Erman, has honoured us by sending hither M. Heinrich Rose, whose work on chemical analysis is a text-book even for the most learned chemists in every country; and whilst his researches on the constitution of minerals, like those of his eminent brother Gustave on their form, have obtained for him so high a reputation, he now brings to us the description of a new metal which he has discovered in the Tantalite of Bavaria.

Switzerland has again given to us that great master in palæontology, Agassiz, and also our old friend Professor Schonbein, who in addition to his report on ozone, to which I have already referred, has now brought to us a discovery of vast practical importance. The "gun-cotton" of Schonbein, the powers of which he will exhibit to his colleagues, is an explosive substance, which, exercising a stronger projectile force than gunpowder, is stated to possess the great advantages over it of producing little or no smoke or noise, and of scarcely soiling fire-arms; whilst no amount of wet injures this new substance, which is as serviceable after being dried as in its first condition. The mere mention of these properties, to which our associate lays claim for his new material, is sufficient to show its extraordinary value in all warlike affairs, as also in every sort of subterranean blasting.

Professor Matteucci of Modena, who joined us at the York meeting, and then explained his various new and delicate investigations in electro-physiology, again favours us with a visit, as the representative of the Italian Philosophical Society of Modena and of the University of Pisa. This ingenious philosopher, who has measured the effect of galvanic currents in exciting through the nerves mechanical force in the muscles, doubtless brings with him such interesting contribution as will add great additional interest to the proceedings of the Physiological Section.

Having already spoken of the rapid progress which the sciences are making in Belgium, through the labours of our associate Quetelet and others, it is with pleasure I announce that M. de Koningk, the palæontologist, who has mainly contributed to this advance and to the solid foundation of the geology of his country by his excellent work on palæozoic fossils, has been sent to us by his own government.

Among these sources of just pride and gratification, no one has afforded me sincerer pleasure than to welcome hither the undaunted Siberian explorer, Professor von Middendorf. Deeply impressed as I am with the estimation in which science is held by the illustrious ruler of the empire of Russia, I cannot but hope that the presence of this traveller, so singularly distinguished for his enterprising exploits, may meet with a friend in every Englishman who is acquainted with the arduous nature of his travels. To traverse Siberia from south to north, and from west to east; to reach by land the extreme northern headland of Taimyr; to teach us, for the first time, that even to the latitude of 72 deg. north, trees with stems extend themselves in that meridian; that crops of rye, more abundant than in his native Livonia, grow beyond Yakutak, on the surface of that frozen subsoil, the intensity and measure of cold in which he has determined by thermometric experiments, to explain, through their language and physical form, the origin of tribes now far removed from their parent stock; to explore the far eastern regions of the sea of Okhotsk and of the Shantar Isles; to define the remotest north-eastern boundary between China and Russia; and finally to enrich St. Petersburgh with the natural productions, both fossil and recent, of all these wild and untrodden lands, are the exploits for which the Royal Geographical Society of London has, at its last meeting, conferred its Gold Victoria Medal on this most successful explorer. Professor Middendorf now visits us to converse with our naturalists most able to assist him, and to inspect our museums, in which, by comparison, he can best determine the value of specific characters before he completes the description of his copious accumulations; and I trust that during his stay in England he will be treated with as much true hospitality as I have myself received at the hands of his kind countrymen.

It is impossible for me to make this allusion to the Russian empire without assuring you that our allies in science on the Neva, who have previously sent to us a Jacobi and Kupffer, are warmly desirous of continuing their good connexion with us. It was indeed a source of great pleasure to me to have recently had personal intercourse in this very town with that eminent scientific navigator Admiral Lutke, in whose squadron his Imperial Highness the Grand Duke Constantine was acquiring a knowledge of his maritime duties. Besides the narrative of his former voyages, Lutke has since published an account of the periodical tides in the Great Northern Ocean and in the Glacial Sea, which I have reason to think is little known in this country. Having since established a "hypsalographe" in the White Sea, and being also occupied from time to time in observations in Behring's Straits, the Russians will soon be able to provide us with other important additions to our knowledge of this subject. Separated so widely as Admiral Lutke and Dr. Whewell are from each other, it is pleasing to see, that the very recommendation which the last-mentioned distinguished philosopher of the tides has recently suggested to me, as a subject to be encouraged by this Association, has been sealously advocated by the former. Let us hope then that this meeting will not pass away without powerfully recommending to our own government, as well as to that of his Imperial Majesty, that a systematic and simultaneous investigation of the tides in the Great Ocean, particularly in the Northern Pacific, be the object of special expeditions,—a subject (as Admiral Lutke well observes) which is not less worthy of the attention of great scientific bodies than the present inquiries into terrestrial magnetism; and one which, I may add, this Association will doubtless warmly espouse, since it has such strong grounds for being satisfied with the results which it has already contributed to obtain through its own grants, and by the researches of several of its associates.

Lastly, in alluding to our foreign attendants, let me say how well our nearest neighbours have responded to our call, who, imitating the example of their enlightened monarch, have proved by their affluence to Southampton, that in the realms of science, as in public affairs, there is that "entente cordiale" between their great nation and our own, of which, at a former meeting, we were personally assured by the profound Arago himself.

No sooner was it made known that the chair of chemistry at this meeting was to be filled by Michael Faraday, than a compeer worthy of him in the Academy of Sciences of Paris was announced in the person of M. Dumas. To this sound philosopher it is well known that we owe, not only the discovery of that law of substitution of types, which has so powerfully aided the progress of organic chemistry, but also the successful application of his science to the arts and useful purposes of life; his great work on that subject, "La Chimie appliquée aux Arts," being as familiar in every manufactory in England as it is upon the Continent.

Nor, if we turn from chemistry to geology, can such of us as work among the rocks be backward in our expressions of thankfulness, in witnessing the goodly attendance of our brethren of the hammer from France, headed by M. ———, who have come to examine, in our own natural sections of the Isle of Wight, the peculiar development of their Paris basin, the identity of their chalk and our own, the fine sections of our green sand and of the Wealden formation of Mantell, and to determine with us "in situ" the strict relations of their Neocomian rocks with those peculiar strata which at Atherfield, in the Isle of Wight, have been so admirably illustrated by Dr. Fitton and other native geologists, and of which such beautiful and accurate diagrams have been made by Captain Ibbotson.

It is utterly impossible that such gatherings together of foreign philosophers with our own should not be productive of much advantage; for he must indeed be a bad statist in science who knows not that numerous are the works of merit which are published in periodicals, or in the volumes of societies of one country, which remain altogether unknown in another; and still less can be acquainted with the present accelerated march of science, who is not aware that the germs of discovery which are lying ready in the minds of distant contemporaries must often be brought into action by such an interchange of thought. The collision of such thoughts may indeed be compared to the agency of the electric telegraph of our Wheatstone, which concentrates knowledge from afar, and at once unites the extremities of kingdoms in a common circle of intelligence.

But although the distinguished foreigners to whom I have adverted, and others, including our welcome associate M. Wartmann, the founder of the Vaudois Society, and M. Prevost, of Geneva, on whose merits I would willingly dilate if time permitted it, are now collected around us; many, among whom I must name M. de Caumont, the President of the French Society for the advancement of Science, have been prevented from honouring us with their presence, because the national meetings in their several countries also occur in the month of September. To remedy this inconvenience, I ventured, when addressing you six years ago at the Glasgow meeting, to express the hope, that each of the national European societies might be led to abstain during one year from assembling in its own country, for the purpose of repairing by its own deputies to a general congress, to be held at Frankfort or other central city under the presidency of the universal Humboldt. Had the preparation of the "Cosmos," and other avocations of that renowned individual permitted him to accept this proposition, which I have every reason to believe the British Association would have supported, I am convinced that many benefits to science would have resulted, and that each national body, on re-assembling the following year in its native land, would have more vigorously resumed its researches.

Adhering still to my project, I beg my countrymen and their foreign friends now present, to sustain this proposition for centralising in a future year the representatives of the various branches of science of different countries, when they may at once learn the national progresses respectively made, and when, at all events, they can so appoint the periods of their national assemblies as to prevent those simultaneous meetings in France, Germany, Scandinavia, Italy, Switzerland and England, which are so much to be deprecated as interfering with a mutual intercourse.

Finally, my fellow-labourers in science, if by our united exertions we have done and are doing good public service, let me revert once more to the place in which we are assembled, and express on your part the gratification I know you experience in being on this occasion as well supported by the noblemen, clergymen, and landed proprietors around Southampton, as by its inhabitants themselves—an union which thus testifies that the British Association embraces all parties and all classes of men.

Seeing near me Her Most Gracious Majesty's Secretary of State for Foreign Affairs, the Speaker of the House of Commons, and other persons of high station and very great influence, who willingly indicate by their presence the sense they entertain of the value of our conferences and researches, let us welcome these distinguished individuals as living evidences of that good opinion of our countrymen, the possession of which will cheer us onward in our career. And above all, let us cherish the recollection of the Southampton meeting which will be rendered memorable in its annals by the presence of the illustrious Consort of our beloved Sovereign, who participating in our pursuits, in many branches of which his Royal Highness is so well versed, thus demonstrates that our association is truly national, and enjoys the most general and effectual support throughout British society, from the humblest cultivators of science to the highest personages in the realm.

Royal Naval Steam-yard, Plymouth.—The total acres of ground to be included in the establishment at Morice Town, is about 75 acres. The contractors have now employed on the works 750 men, 110 horses, 3 steam-engines, with 12 miles of railway. 630,000 cubic feet of stone (granite and lime-stone) are on the ground, and they are working seven of the principle quarries of the country. The works will go forward with the greatest rapidity, and it is expected that a steamer will be admitted into one of the basins within three years and a half from this time. The coffer dam, which the enterprising contractors, Messrs. Baker and Son, have undertaken on their own responsibility, is 2,000 feet long, within which the seawall of the same length is to be built. There will be two immense basins, the north basin, 650 feet by 625 feet, and the south basin, 625 feet by 560 feet, each having a depth of 27 feet of water at all times, and will allow of 18 first-class vessels to be fitted out, or 25 of all classes, exclusive of those in the docks. The two basins contain 16 acres. There will be three large docks; one (the north dock) 360 feet long by 94 feet wide for first-rates; another 406 feet long by 82 feet wide, for the largest steamers; and the third (the south dock) 300 feet long by 82 feet wide.

REVIEW.

Experimental Researches on the Strength and other Proportions of Cast Iron. By Eaton Hodgkinson, F.R.S. London: Weale, 1846. 8vo. pp. 200. Five plates.

The first part of this work which is a new edition of Tredgold's Treatise with additional notes by Mr. Hodgkinson, appeared in 1842; the second part now before us is entirely written by Mr. Hodgkinson, and though it is published as a separate volume, the pagination is continued on from the preceding one. The principal distinction between the two works is that the former treated of the effects produced upon bodies by forces small compared with those necessary to produce fracture, whereas the present volume refers almost exclusively to the ultimate strength of cast iron, or the capability of resisting fracture.

The subject is divided into four parts, the strength to resist, 1st, longitudinal tension; 2nd, longitudinal compression; 3rd, transverse pressure (the case of girders); 4th, tension; the course of experiments under each head is explained at length, and the results tabulated: a mathematical investigation of the theory of the strength of beams is also given.

The first part of the work which considers the tenacity of cast iron occupies but a small space, as the subject offers comparatively little difficulty to the experimenter—the following concluding remarks will sufficiently show the nature of the results.

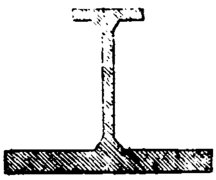
"With these facts before the reader, he will, I conceive, be unable to see how the mean tensile strength of cast iron can properly be assumed at more than 7 or 7½ tons per square inch; but some of our best writers have, by calculating the tensile strength from experiments on the transverse, arrived at the conclusion that the strength of cast iron is 10, or even 20 tons, or more. Mr. Barlow conceives it to be upwards of 10 tons (Treatise on Strength of Timber, Cast Iron, &c., p. 222), and Mr. Tredgold makes it at least 20 (art. 72 to 76). The reasoning of Mr. Tredgold, by which he arrives at this erroneous conclusion, with others resulting from it, will be examined at length under the head 'Transverse Strength.' Navier, too, (Application de la Mécanique, article 4,) calculates the tensile strength of cast iron from principles somewhat similar to those assumed by Tredgold, and finds it much too high."

In considering longitudinal compression the experiments are divided into two classes, those upon long and those on short pillars, as the former usually broke by bending, and the latter by crushing; and consequently the laws for the two cases widely differ. Under this head we find the following interesting results.

"The strength of a pillar in the form of the connecting rod of a steam engine was found to be very small; indeed, less than half the strength that the same metal would have given if cast in the form of an uniform hollow cylinder. The ratio of the strength, according to my experiments, was 17578 to 39645. A pillar irregularly fixed, so that the pressure would be in the direction of the diagonal, is reduced to one-third of its strength, the case being nearly similar to that of a pillar with rounded ends, the strength of which has been shown to be only ⅓rd of that of a pillar with flat ends. Tredgold, art. 283 of his work on Cast Iron, and in his Treatise on Carpentry, following the idea of Serlio in his Architecture, recommends circular abutting joints, to lessen the effect of irregularity in the strains upon columns, from settlements and other causes; but this, we see, is voluntarily throwing away two-thirds of the full strength of the material to prevent what may often be avoided."

The question of transverse strength occupies the greater part of the book. The first point ascertained is how far bars of cast iron will bear the long continued pressure of weights which are not sufficient to break them immediately. The effect of temperature and defect of elasticity are next considered, and lastly the general laws of the transverse strength of beams. The experiments instituted are extremely numerous, the results tabulated are derived from researches extending over a great number of years, and are of course invaluable. The information given with respect to bars of rectangular section is so full and complete as to almost exhaust the subject; when however Mr. Hodgkinson investigates the strength of beams varying in their rectangular section, and endeavours to ascertain the form of uniform strength, he leaves room for further inquiries. Before commenting on this most important part of the subject, we must let our author explain for himself the mode of investigation which he has adopted.

"The ribs in the model were first made equal, as in the beam of strongest form according to the opinion of Mr. Tredgold (Section IV., art. 37); and when a casting had been taken from it, a small portion was taken from the top rib, and attached to the edge of the bottom one, so as to make the ribs as one to two; and when another casting had been obtained, a portion more was taken from the top, and attached to the bottom, as before, and a casting got from it, the ribs being then as one to four. In these alterations the only change was in the ratio of the ribs, the depth and every other dimension in the model remaining the same. Finding that all these beams had been broken by the bottom rib being torn asunder, and that the strength by each change was increased, I had the bottom rib successively enlarged, the size of the top rib remaining the same. The bottom rib still giving way first, I had the top rib increased, feeling that it might be too small for the thickness of the middle part between the ribs. The bottom rib was again increased, so that the ratio of the strengths of the bottom and top ribs was greater than before; still the beam broke by the bottom rib failing first, as before. As the strength continued to be increased more than the area of the section, though the depth of the beam and the distance between the supports remained the same, I pursued, in the future experiments, the same course, increasing by small degrees the size of the ribs, particularly that of the bottom one, till such time as that rib became so large that its strength was as great as that of the top one, or a little greater, since the fracture took place by a wedge separating from the top part of the beam. I here discontinued the experiments of this class, conceiving that the beams last arrived at, were in form of section nearly the strongest for cast iron."



The form of the strongest section thus ascertained was, as shown in the adjoined diagram; the ratio of the sectional area of the top and bottom was as 1 : 6; so greatly does the compressive strength of cast iron exceed its tenacity. The depth of this beam was uniform throughout. but thickness lessened towards each end, so that the *plan* of each flange was lens-shaped, the curves being portions of a parabola. This form has been shown theoretically to be that which makes a beam of uniform depth equally strong in every part.

The omissions in Mr. Hodgkinson's inquiry, or rather the subjects in which he has left room for further inquiry, appear two-fold. In the first place, the object of his experiment was confined almost entirely to ascertaining the proper proportion of the two flanges to each other; and secondly, the flanges were always thin, compared with their width, and of a rectangular section. The proper form and dimensions of the vertical rib, seem to have been comparatively neglected; and it was not ascertained whether for a given quantity of material, additional strength might not be attained by making the bottom flange *of greater vertical depth in proportion to its width.*

The strongest beam is that of uniform strength, or that which when it tends to break has that tendency in every part; consequently the best form is that for which the beam tends to give way in both flanges, and the vertical rib simultaneously. Moreover, the tendency to give way must be equally exhibited in every part of each of these members: the beam when the load is placed at its centre, must not tend to give way sooner in the middle than towards the ends, nor to fail in the flanges sooner than in the rib. Now Mr. Hodgkinson's beams always broke in the middle, and the failure was always in one of the flanges.

It is a great mistake to suppose that the vertical rib ought to be as thin as possible. Where nearly the whole strength is contained in the flanges, the rib need not usually possess much strength towards the centre, but it ought to be increased in strength towards the extremities; and the law of increase has been clearly shown in a former page of this Journal (*ante* p. 174). The consideration of the exact nature of the forces acting on the vertical rib, seems to have been overlooked in our theoretical books; and it ought to be made the subject of an altogether new class of experiments.

The next question on which it appears to us further experiments are wanted, relates to the possibility of improving the sectional form of the flanges themselves. It has been usually considered that they ought to be two thin wide laminæ, and the object for adopting this form is, that the material may have the greatest possible leverage about the neutral axis. Mr. Hodgkinson evidently falls in with this notion, which, as we think, arises from erroneous conceptions of the action of the vertical rib. We are strongly inclined to pronounce the bottom flange in the section given above, *too thin for its width*, It does not seem very hazardous to predict that, all other things remaining the same, the strength would be greatly increased by doubling the thickness of this flange.

It seems clear that the part of the metal in the immediate neighbourhood of the vertical rib will be more acted upon than the outer or more projecting parts of the flange. These are comparatively inefficient; for to suppose that all parts of the flange, because nearly at the same distance from the neutral line, therefore exert the same elastic force—what is this but assuming in another form the old exploded notion of the incompressibility or inextensibility of the material? The parts projecting the greatest distance beyond the vertical rib will be least acted upon, and consequently the great object ought to be to collect the material of the flanges as closely about the upper and lower edges of the rib as is compatible with other considerations. Under this head also new experiments might be advantageously instituted.

In the theoretical investigation of the transverse strength of beams, Mr. Hodgkinson does not adopt the theory of John Bernoulli, Mariotte, Prof. Moseley, and others, that the elastic forces of the fibres are proportional to their distance from the neutral axis, but represents those forces by an expression $ax-\phi(x)$ *where* $\phi(x)$ is "a function representing the diminution of the force in consequence of the defect of elasticity." He is disposed to conclude from experiment that for cast iron this function would be of the form bx^2.

The present treatise shows clearly enough that the old assumption leads to erroneous results. We may furnish the following proof in addition to those given by him. We recently had the curiosity to apply the formulæ given by Professor Moseley (p. 507 & 513) for the deflection of beams to several cases of the experiments relative to the Menai Bridge, detailed in this Journal, p. 147, and found the deflections so calculated six or seven times as great as those actually observed. This seems to us quite sufficient proof that the old theory is not to be trusted; it is indeed founded on an assumption which it would be very difficult to prove, that the centre of curvature for all the filaments of the beam, and for the bounding surfaces, coincides with the centre of curvature of the neutral line.

But although Mr. Hodgkinson has probably made an improvement in the theory in the particular here alluded to, we by do means assent to one of the assumptions on which this theory proceeds, namely, that the parts of the section will be extended or compressed according to their distance from the neutral. We think that enough has been said to show that the bottom flange cannot be in a state of uniform tension throughout at equal distances from the neutral axis. At all events this ought to be proved before it is assumed.

It should be mentioned that the works before us contains a large portion of the results already communicated in reports to the British Association. The theory of the strength of materials is daily assuming a more complete form; in fact there is scarcely any branch of the philosophy of engineering of which so much is known. The subject is one which has been illustrated by the splendid talents of Euler, Bernouilli, and many others of almost equal celebrity: but the merit must undoubtedly be awarded to Mr. Hodgkinson, of having *realised* the investigations, and of having given to them that certainty and method which alone can render them useful to the practical engineer.

WILLIAM OF WYKEHAM.

The annual volume of the Archæological Institute is just published. It refers almost exclusively to the architecture of Winchester. The following extract, from a paper by Mr. Cockerell, will show that we are not singular in our notions of the necessity of faithfulness in architecture. The extract refers to the artistic merits of one who, if worthier notions of the fundamental principles of art were generally entertained, would be esteemed incomparably the greatest of English architects:—

"The chief expression of Wykeham's architecture is its constructive character; throughout we trace the sound builder, the able mason, the ingenious carpenter, whose well-designed operations satisfying the mind, carry with it the fancy, by natural consequence, in harmonious consent; and an unsought felicity follows as a matter of course. He wrought out his design through the model, and an intimate knowledge of the materials. and careful consideration of the wants and requirements on the spot. His cornices and labels and water tables explain their purposes of carrying off the wet; the buttresses are never for ornament alone, but proportioned to the support and durability of the edifice. No parasitical excrescences obtrude themselves ostentatiously, no parts and prettinesses are indulged which may not be accounted for by a natural grace and logical fitness. . . . . . He was one of the first to recognise the utility of the four-centred arch, and to employ its depressed form where a superincumbent floor made it convenient. It is probable that he did not encourage that fashionable adoption of it, which introduced it (under Edgington, his predecessor in the see of Winchester) into the cathedral itself, for we find uniformly the two-centred arch in his halls and chapels; while the four-centred was confined to situations of limited elevation. He was one of the first to condemn the tenuity, elongation, and weakness, real and apparent, of the Lancet and Decorated style, and to introduce the so-called Perpendicular, which, fortified by its mullions or constructive subdivision of skeleton framing, or network, the enormous openings then demanded by the growing fashion of fenestral decoration; as Chaucer says,

richly peint
With lives of many divers seint.

He abandoned the high-pitched shingle roofs, excluding sun and air, and was one of the first to employ the low pediment, and roof covered with lead; and in his works we first discover the hammer-beam roof in all its varieties—a system of the highest ingenuity and constructive economy, both for space and material, as well as beauty and power, as exhibited in Westminster Hall, Eltham Palace, Windsor Hall, and our college chapels and halls.

BARKER'S MILL.

Sir—Perhaps through your valuable journal you would be kind enough to decide the following argument:—*Doctor Barker's Mill.* One gentleman argues "that the power is obtained by the resistance of the atmosphere to the egress of the water, thereby causing a reaction."

The other gentleman denies such to be the cause, and says, "that it would revolve with greater power if placed in vacuum." Leaving it for you to decide, with many apologies. I remain, Sir, your obedient servant,

A Constant Reader.

In Barker's Mill the supply of water is obtained from a cistern placed at a considerable height above the revolving tubes or arms, which, if the orifices of them were stopped, would sustain a hydrostatic pressure acting equally in all directions, and proportioned to the depth below the surface of the water in the reservoir. When, however, the orifices are opened, there is, in each revolving tube, a predominating pressure on one side of it; for it is clear that the internal area of one side of the tube exceeds that of the other sides by a quantity equal to the area of the orifice.

The motion is in the direction of that side of the tube which sustains the greatest pressure. The external air is a cause rather of retardation than acceleration, on account of its resistance to each arm on the side opposite to the orifice. It may be easily conceived that if the atmospheric pressure accelerated the motion, an increase of that pressure would increase the accelerating force. If this view were correct, the arms ought to revolve more rapidly if immersed in mercury, which certainly would not be the case.

Very similar to Barker's mill in its mode of action is the rocket used in pyrotechny and for military purposes. Here the ignited powder generates an elastic gas, which presses on one end of the chamber containing it, but escapes by the open end; the motion is, of course, in the direction of the end subjected to the elastic pressure. The external air tends to retard the escape of the gas, and, to a certain extent, increases its pressure by partially confining it; but the accelerating force so gained is far more than compensated for by the resistance which the air acting on the external surface of the rocket offers to the motion—a resistance varying nearly in the square of the velocity.

The revolving steam-machine of Hero, of Alexandria, is another instance of the application of the same mechanical principles as those of Barker's Mill.

The apology with which our correspondent concludes his note is quite unnecessary; we know no better way of serving the interests of our subscribers than by considering questions like the present as they arise, and contributing as far as we can to the solution of them.

ST. MICHAEL HEAVITREE.

Mr. Editor—In this month's Journal, at p. 291, under the head of St. Michael Heavitree, is a small paragraph relative to the new church there, which was designed by me, and executed under my sole superintendance. The paragraph is altogether erroneous; and how it could have crept into your paper, generally so accurate, I am a loss to think. Who Mr. Alexander is I cannot think, no such a person was ever in any way connected with the matter. Will you please in your next number to correct this. If you can find, next month, space for a few concise particulars relative to the church, which is a large one, and esteemed highly in this city, you would oblige, and I would with pleasure send them.

Your very faithful Servant,
David Mackintosh, Architect.

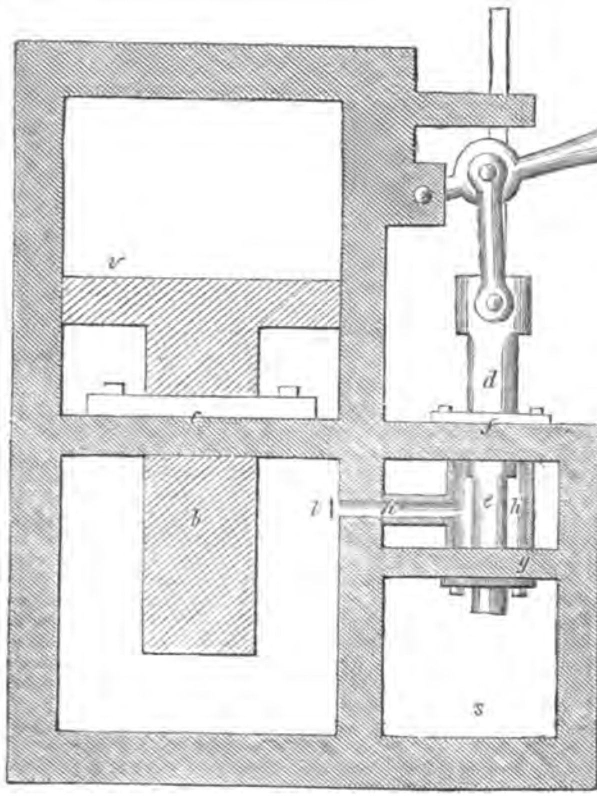
Exeter, Sept. 2, 1846.

For the following additional particulars we are indebted to Mr. Mackintosh, who has forwarded them at our request:—

This church has been rebuilt on an extensive scale, and in a most substantial and permanent manner. The style is that of the Fifteenth Century, and all the peculiar characteristics of the ancient church (a small edifice of early perpendicular date) have been carefully maintained and restored. The dimensions within the walls are as follows:—chancel 25 ft. 0 in. by 16 ft.; nave 86 ft. by 22 ft.; north and south aisles each 94 ft. by 13 ft. 6 in., with a southern porch in the second bay from the west end. The height from the stone flooring to the summit of the open roof internally is 44 ft. 6 in. The vestry is placed at the eastern end of the north aisle; externally the walls above the plinth are built with lime stone of a blue grey tint, from Chudleigh, and the windows, string courses, battlement, mouldings, and other dressings are of Caen stone. The plinth is of granite; the walls 3 ft. in thickness, and the gables are surmounted by floriated crosses of rich character. The church internally is remarkable for the high pitch of its fine open roof, consisting of 13 pair of grained principals with circular ribs of oak, wrought and moulded, and enriched with carved bosses coloured and gilt after ancient ones in the old church; the principals spring from richly carved stone cubals, and the columns and arches separating the nave from the ailes, are a restoration in every point as regards detail of those in the old church. They are especially rich and varied in their foliage and capitals, and are carved with much spirit and vigour—illustrations of these capitals are intended to be published by the Exeter Architectural Society in their transactions. There is a fine chancel arch, richly moulded in Caen stone, on the north side of which is placed the pulpit, hexagonel in form, and an elaborate specimen of stone carving, executed by Rowe, of Exeter; it abounds in rich foliage, varied in each compartment, and carved in bold relief, having niches surmounted by crocketted canopies over figures of the four Evangelists and St. Michael the Archangel. There is a fine eagle carved in old oak, and an open Litany desk. The eagle was carved by Mr. Winsor, who is the senior verger of Exeter Cathedral. All the carved works in this edifice are admirably executed, and prove the great advance lately made in the correct execution of wood and stone carving. At the east end of the chancel it was at first intended to have restored the former window, but on inspection, being found much decayed, as well as of a somewhat debased architectural character. The Rev. Dr. Warren, of Portview, liberally presented a new window of four lights, and the Rev. Arthur Atherley (the Vicar) has munificently filled the same with stained glass at his own expense. The design of this glass, which has been executed in a most satisfactory manner by Mr. Robert Beer, of Exeter, a talented and rising artist, comprises figures of the four Evangelists under storied canopies having scrolls at their feet, on which are texts having reference to the Supper of our Lord. In the upper tracery are placed the Phœnix and Pelican; the Symbols of the Evangelists; the Virgin and Infant Jesus; and St. Michael (the patron Saint of the Church) in conflict with the Dragon. The south window of the chancel has a fine figure of the Virgin bearing in her hand her emblem, the Lily. In the south aisle there is a good specimen of a memorial window of three lights. The first and third are bordered after a specimen in Exeter Cathedral, in a flowing pattern and blue glass, with the "Crown" quarry within, the centre bordered in ruby glass with the "Trinity flower" quarry, the family arms, and badge of the order of the Bath being inserted. At the bottom of the window the names of the father and his two sons, buried in the adjoining church yard are recorded, and the scripture "blessed are the dead which die in the Lord" runs through the lights. The font is the gift to the church by an old parishioner; it is of Caen stone, large, aud highly enriched; it is placed near the western entrance. The bowl is octagonal, having each panel filled with ornamental tracery, varied in each compartment; the sides of the shaft are likewise panelled with cinque foil beaded arches, and springing from the shaft to support the bowl, are a band of angels with expanded wings, bearing shields. For the present the old tower still remains, but it is hoped, ere long, to add an adequate tower and spire, which when complete, will render this one of the largest and finest churches in the county of Devon. The contracter for the whole of the works was Mr. John Henshole, of Heavitree, who has fulfilled all his obligations in the most satisfactory manner. The works have been well done and unworthy imitations avoided.

DIFFERENTIAL HYDRAULIC PRESS.

I think it must be evident to all who have thought on the subject, how much superior the Hydraulic Press is to the Screw, where enormous pressure is required; but even in the hydraulic press, as at present made, if we wish to increase its power to a great extent there appears but three ways of accomplishing it, all of which are liable to objection: the first plan is to increase the size of the large piston and cylinder, thus making it more expensive and unwieldy; the second is by diminishing the size of the smaller piston, but if this is carried too far it will be in danger of bending or breaking under the pressure which is applied to it; the third is to obtain greater leverage upon the small piston, which if carried too far will also be in danger of injuring it. But it appears to me that it is possible to diminish the acting part of the piston to almost any extent, while its strength remains the same, by the plan which is given in the figure, in which *b* is the large piston working in the stuffing box *c*, and carrying the press-board *s* upon it; *d e* is the small piston or forcing pump thicker at the part *d*, than at *e*, and works in the two stuffing boxes *f* and *g*, and is nearly at the top of its stroke. *h* is the pump cylinder communicating with a reservoir in this cylinder, the small piston works, descending through a water-tight collar into the space *s*, which is open to the air. *k* is a pipe communicating with the large cylinder at the end of which is a valve *t* opening outwards. Then if we suppose the cylinders to be full of water, and the piston at the top of its stroke, when it is pushed down it will force a quantity of water into the large cylinder, *nearly equal to*



the difference of the solidity of the two parts of the piston d e, which will be a very little if the two parts *d* and *e*, are nearly alike; thus giving it the advantage of a small piston while it still possesses the strength of a large one. I have not marked the handle and other parts as they do not differ from the usual construction.

A Working Mechanic.

Newcastle-on-Tyne.

[The above suggestion is very ingenious, and appears likely to prove valuable. As the principle of the press in its improved form is to pump into the main cylinder a quantity of water equal in volume to the *difference* between the solid contents of the two pump-pistons we have ventured to apply the name Differential Hydraulic Press

During the military operations of the French in Algeria it was necessary to export from France hay for the cavalry horses, and in order to compress the hay into the smallest possible compass, it was subjected to the action of the hydraulic press. But it was found that the operation was excessively slow, as during the first part of it a very large quantity of water was pumped in with little or no resistance from the compression of the hay. A similar difficulty frequently occurs on less important works than that of maintaining a new colony, and a very simple addition to the pump here described would probably remedy the evil.

Let the cylinder to be continued down into the space *s*, and let this lower cylinder communicate by a pipe, having a stop-cock, with the reservoir, and also by a pipe similar to *k*, with the main cylinder. When the pressure at *v* is small a large quantity of water may be pumped in at each stroke, and if the stop-cock be open, the upper and lower pump pistons will both draw water. When the pressure at *v* becomes great, the stop-cock may be closed and water will be forced from the upper pump cylinder only.

By this contrivance two relative rates of working are obtained. Three or more rates of working might be obtained by having three or more sizes of the pump-piston and a corresponding number of cylinders.]

REGISTER OF NEW PATENTS.

If additional information be required respecting any patent, it may be obtained at the office of this Journal.

HEATING BY HYDROGEN.

Joseph Pierre Gillard, of Rue Martignac, Paris, professor of mathematics and philosophy, for "*Improvements in the production of Heat in general.*"—Granted February 11th, 1846; Enrolled August 11th, 1846.

The improvements relate to the application of pure hydrogen for heating apartments, steam engines, furnaces for smelting, and other purposes. The hydrogen is obtained by driving jets of steam through red hot retorts containing thin iron plates, when the oxygen of the steam forms an oxide on the iron, and the hydrogen of the water is set free and carried off by pipes to suitable gasometers. Another process for obtaining hydrogen is by injecting steam, with pulverized coal or coke, into red hot retorts, by which means carbonic acid and carburetted hydrogen gases are formed; these gases are carried off by pipes to a purifier containing lime-water, when the carbonic acid is absorbed, and the carburetted hydrogen carried with another jet of steam through a second red-hot retort, when the carbon is decomposed and united with the oxygen of the steam forming carbonic acid, and at the same time the hydrogen of both the steam and the carburetted hydrogen is liberated; thus pure hydrogen is obtained, which is carried off to the gasometer, and at the same time the carbonic acid is passed to a second purifier, where it is absorbed.

For heating apartments two pipes and two gasometers are employed, one furnished with hydrogen, and the other filled with atmospheric air; the pipes are so conveyed to jets at the spot, that the gases may be mixed before the combustion takes place. Two volumes of air to one of hydrogen will be required for proper combustion.

For locomotive engines, there are to be introduced into the space occupied by the fire-box, four or five retorts, as first described, for obtaining hydrogen; and the tender is to have two or three gasometers, to hold the hydrogen and atmospheric air, from which the gases are to be conveyed by pipes to burners in the engine, for heating the retorts red hot, and at the same time the water in the boiler. When the steam from the engine-boiler has passed through the cylinders, instead of its escaping into the open air, it is to be conducted by pipes to the retorts, where it is decomposed, and the hydrogen passes from the retorts by pipes to the gasometers in the tender for supplying the engine.

ZINC PAINT.

James Murdock, of Staples-inn, Middlesex, mechanical draughtsman, for "*an Improved process for preparing a certain material for the purpose of painting.*" (A communication).—Granted February 11; Enrolled Aug. 11, 1846.

This invention relates to obtaining pure oxide of zinc, to be used for painting instead of white lead. Zinc, or zinc ore, is put into a fire-clay retort, open at both ends; at one end the charge of zinc or ore is placed and then sealed up; the other end is left open, and communicates with a chamber. When the retort is heated, the zinc passes off in a state of vapour, and as it comes in contact with the atmosphere it unites with the oxygen of the air, and forms the oxide of zinc, the vapour floating in the chamber like a white cloud. For the purpose of collecting the oxide, a series of fine wire sieves are placed in a passage leading into another chamber; this chamber communicates with the large chimney of the retort furnace, and thereby causes a strong draught of air to pass from one chamber to the other, through the wire sieves; in doing this, the current of air carries with it the fine particles of the oxide of zinc, and deposits them on the wire sieves, which are occasionally shaken to prevent their being clogged.

MOTIVE POWER.

James Nasmyth, of Arundel-street, Middlesex, gentleman, for "*certain Improvements in engines or machinery for obtaining and applying motive power.*"—Granted Feb. 16th; Enrolled August 16, 1846. (Reported in *Patent Journal.*)

These improvements consist in the construction and working of engines in a novel manner, by the agency of steam or other elastic fluids, or other means, whereby a greater amount of power is obtained than by means ordinarily employed. In this improved plan, two, three, or more cylinders may be employed, as may be required, and the power of the motive agent, whether it be steam, air, or gases, or any other pressure, is made to act alternately, first at one end of the train of cylinders, and then at the opposite end, that is to say, if there be two cylinders connected together by a tube, the motive agent is admitted alternately above the piston and at the upper end of each cylinder, each being in vacuo alternately. If more than two cylinders are used, they are put in connection with each other by means of tubes, the additional cylinders, whatever may be their number, are always in pleno (that is to say), they are filled with air, or some other elastic or non-elastic fluid, the pistons of which cylinders move up and down simultaneously with the two end cylinders. The pistons of the two end cylinders or of those which are alternately in vacuo as before explained, are actuated alternately by the introduction of the motive agent into the cylinders above the piston. On the opposite side of the piston the space which intervenes between the pistons of the two steam cylinders, is occupied with air or any other elastic, or non-elastic fluid, not susceptible of condensation. It will be understood that the tubes which connect the cylinder together, as well as the additional cylinders, which are placed between the two end ones, are also kept full of air or other elastic or non-elastic fluid, not susceptible of condensation; therefore the power received by the piston of either of the two end cylinders, which are alternately in vacuo, is simultaneously transmitted to any other piston or pistons in any other cylinders which may be situated between the two end ones, and these additional cylinders may be placed at any distance or in any position that may be required, always provided that the communication is kept up by means of tubes.

If two cylinders only be employed, they are connected with each other below the piston by a tube, steam only being admitted above the pistons alternately; therefore when the steam exerts a force to depress the one, the opposite piston is acted on by the exhaustion from the condenser, also by the elastic or non-elastic fluid rushing from one cylinder to the other.

When air compressed, or any other elastic fluid, is employed as the motive agent, it is admitted in the same manner as steam, and the same effect will result from the same arrangement of cylinders and the connecting tubes, whether the cylinders be two or more; with this difference, that the air which has followed the piston must be withdrawn by air-pumps out of the cylinder, in order that there may be a vacuum above the piston.

LOCOMOTIVE ENGINES.

ROBERT NISBET, of Lambden, Esq., for "*certain Improvements in Locomotive Engines and Railways.*"—Granted February 19; Enrolled August 19, 1846.—*Reported in the Patent Journal.*

These improvements consist in making such additions to engines and railways, as to enable a train to ascend, at a very slightly diminished speed, almost any incline. A toothed circle or ring is bolted, or otherwise secured to the rim of each driving wheel of the locomotive engine, or, if necessary, a circle of teeth may be attached to each side, the diameter of which, at the pitch line, must of course be the same as the diameter of the sole or bearing periphery of the wheel. Racks corresponding with these toothed rings are laid down at the inclined portions of the railway, and may either be secured to seats formed in the chairs for their reception, or bedded on separate longitudinal sleepers laid for that purpose; they are continued beyond where the gradient commences, to the distance equal to the length of the longest train likely to travel thereon; at the beginning, or where the toothed rings first take into these racks, the pitch line is placed below the level of the rails, and the teeth at the same point are bevelled off on one side to a sharp edge. From this it gradually rises until it attains a proper level, and the teeth at the same time are bevelled less in proportion as they rise, until they assume a proper shape. This arrangement will facilitate the junction of the rings with the racks, and prevent any possibility of the teeth of the one coming opposite the teeth of the other.

On railways intersected with many crossings, he prefers making use of only one circle of teeth to each wheel; this he places on the inside, as where the flange passes there will be room for it; also by cutting a portion of the rail away, through which it may pass freely.

By another arrangement, the toothed rings are secured to the driving wheels by means of four short links, on which they swing, placed at equal distances on the circumference, and will admit of their being raised two or three inches, so as to clear the rails in crossings, or any other obstructions likely to be met with. The toothed rings, in this case, are acted on by a lever, over which the driver has control, who raises or depresses them accordingly,

He states that he is aware that toothed wheel and racks have before been applied to railways, throughout their entire length, and which method of propulsion he does not claim. But he claims the fixing of toothed circles or rings to the driving wheels of locomotive engines, for the purpose of ascending inclines, and also for retarding in its descent. (This is not new. —Ed. C. E. and A. Journal.)

VENTILATION OF MINES.

WILLIAM PRICE STRUVE, of Swansea, civil engineer, for "*Improvements in ventilating mines.*"—Granted March 11; Enrolled Sept. 11, 1846.

The improvements relate to an apparatus for exhausting the air out of mines, for the purpose of ventilating them and withdrawing explosive gases formed therein. The patentee proposes to effect these objects by an apparatus, that will draw a continued current of air through the upcast shaft of the mine, consisting of two large cylindrical tanks built of masonry or other suitable material, partially filled with water; within the tanks are to be suspended two inverted chambers similar to gasometers. From each tank two air-tight enclosed passages are to be formed leading to the upcast shaft, one passage to lead from the top of the tank above the inverted chamber, and the other passage to lead from the underside of the inverted chamber, just above the water line; each of these passages are to be furnished with valves opening inwards, and also with valves opening outwards to the external air, the valves to be of the same area as the upcast shaft, and are recommended to be made in compartments of plates of metal faced with leather, bolted on to a framing, the leather forming a hinged joint.

For working the apparatus a horizontal shaft is set in motion by a steam engine, or other power. This shaft passes through the sides of the tanks to the centre, and at each end of the shaft is fixed a crank, attached to a connecting rod; the upper end of the rod is fixed to the centre of the inside of the top of the inverted chamber. When the shaft is set in motion, the cranks, which are set at each end of the shaft opposite to each other, are made to rotate, and by them the connecting-rod causes the inverted chambers to be raised and lowered alternately, so that at each stroke of the engine a quantity of air is displaced equivalent to the capacity of the two inverted chambers. By this arrangement the air is withdrawn from the upcast shaft to each tank through the inlet valves, first under the inverted chamber, then over it, and as the chamber rises the air is expelled out of the tank above the chamber through the outlet valve, and at the same time the interior of the chamber is being filled with air from the upcast shaft, and when the chamber descends the outlet valve is closed, and air is drawn from the upcast shaft through the inlet valve to the upper part of the tank above the chamber, and at the same time the air is forced out of the interior of the inverted chamber through the outlet valve. Thus a continued current of air is being withdrawn from the mine through each tank.

ELECTRIC TELEGRAPHS.

HENRY HEIGHTON, M.A., of Rugby, Warwickshire, for "*Improvements in electric telegraphs.*"—Granted Feb. 3; Enrolled Aug. 3, 1846.

This invention relates to the introduction of an apparatus to supply the place of the magnetic needle now used for electric telegraphs. The apparatus consists of a glass tube fitted with brass caps at top and bottom, and having a strip of metallic leaf (gold leaf is recommended as best) passing through the centre of the tube, loosely hung in metallic contact with the brass caps; the upper extremity of the leaf being fixed at right angles to its lower end, so that the leaf, from whatever direction seen, will present at some part its flat surface to the eye. The brass caps are placed in a circuit suitable for electro-telegraphic communication. Near to the leaf (as on the outside of the glass) is placed either of the poles of a magnet. The effect of this arrangement is, that when a current of voltaic electricity is caused to pass through the circuit, and thereby, the metallic leaf, the latter is deflected to one side or the other, according to the direction of the current; and the distinct motion so obtained may be repeated and combined and used for the purpose of designating letters or figures or other conventional signals. One of the apparatus is to be placed at each terminus of telegraphic communication, and others may be placed at intermediate points, each to be provided with a voltaic battery and one of the key-boards used in single magnetic-needle electric telegraphs.

NOTES OF THE MONTH.

Bavaria Canal.—This canal, which has been opened for a few months, promises to be of the highest importance to commerce, by it the Rhine and Danube, and consequently the Black and North Seas are united. A vessel can transport its cargo from London or Rotterdam across Bavaria, Austria, Hungary, and Wallachia, as far as Trebizond and Constantinople, This canal, bearing the name of *Ludwigts Kanal*, was executed by the King of Bavaria.

Telegraphic Wires.—A new coating has been applied to the wires of the Munich and Augsburg railway telegraph, the invention of Professor Steinheil, of Munich, it possesses the properties of protecting the wires from lightning.

We are happy to announce, observes the *Athenæum*, that the Budrun Marbles, secured to us by the exertions of Sir Stratford Canning, have arrived from Asia Minor, and are now safely deposited in the British Museum. The pieces of frieze of which this most interesting collection consists have been removed from the walls of the Turkish fort into which they were built; and where they have, from time to time, been noticed by European travellers—though no very critical account of them has ever been published. Budrun, as is well known, occupies the site of the ancient Halicarnassus; and it has, with great probability, been supposed that these sculptures formed part of the celebrated mausoleum erected, in that city, by Artemisia, Queen of Caria, to the memory of her husband, Mausolus, B.C. 350—and have, like the frieze of the Temple of Victory, at Athens, been used by the Turks as the building materials of a fort erected on the site of this monument. If this opinion be correct, these sculptures have an historical value scarcely less than those of the Parthenon: for we learn from ancient writers that the frieze of the Mausoleum was the work of four of the most celebrated artists of the day,—Bryaxis, Leochares, Scopas, Timotheos,—or, according to Vitruvius, Praxiteles. The Budrun Marbles would thus represent the style of a period in the history of Greek sculpture, of which, from the want of dated monuments, our knowledge is most uncertain,—the century preceding the reign of Alexander the Great, and distinguished in the history of art as the Praxitelian period. We will describe these sculptures as far as a first hasty examination will enable us. The subject, like that of the Phygaliau and Lycian friezes, is a battle with Amazons. At the first glance, we are struck by the masterly composition of the groups, the knowledge and skill which distinguish the Athenian school. As the eye dwells longer and compares more critically, we perceive certain perculiarities distinguishing the style from that of the older Greek friezes with which we are acquainted. With no trace of the careless, barbaric ignorance so apparent in the Lycian friezes, with more elaborate and skilful execution than the Phygalian, these sculptures still want the simplicity, repose, and unconscious beauty of the art of Phidias. Though the general composition is finely conceived, the design and treatment are not without mannerism. The true proportions of the figures, when compared with those of the Elgin sculptures, appear unnaturally elongated; and the graceful flow of the draperies is singularly contrasted with the poverty and meagreness of some of the anatomical details and the constraint of the attitudes. We are at once reminded of Pliny's description of the new style introduced by Lysippus;—who, in order to give greater height to his figures, substituted a greater dryness of treatment for the squareness, and full muscular development of the earlier school. With this change in the type commenced that general decadence in Art which may be traced step by step in the coins of the Seleucidæ, and other successors of Alexander; and which, from the evidence of the Budrun marbles, according to their presumed date, must have been already introduced B.C. 350. This is rather an earlier epoch than that from which the decline of sculpture is usually dated: and it must be confessed that the Budrun friezes, when compared with the reliefs of the choragic monument of Lysicrates, a contemporary work, and other sculptures considered to be of the same period, exhibit far more strikingly the characteristic of decadence; and might, in the absence of all historical data, be assigned with great probability to the century after the death of Alexander, B.C. 329. We will not, however, here anticipate a discussion involving the historical research and critical knowledge of art which will be required to solve the question whether the Budrun Marbles can be identified with the friezes of the Mausoleum. The surface of the sculpture is tolerably preserved—the marble not of very fine quality.

Launch of an Iron Steamer at Liverpool, built by Messrs. Vernon and Co., took place on the 8th of September, she is named the Haddington, and is built for the Peninsular and Oriental Steam Navigation Company. Her dimensions are length between perpendiculars, 221 feet, over all 240 feet, breadth of beam 35 feet, depth of engine room 21 feet tonnage, new measurement 200 tons. The engines are of 450 horse, constructed on the direct action principle by Messrs. Bury, Curtis and Kennedy, of Liverpool.

The Norman Tower at Bury.—The great eastern arch is removed, and the superstructure will be supported by shores until the insertion of the new arch is completed.

Excavations in the Acropolis.—The Archæological Society of Athens are busily pursuing the work of investigation. We trust they may be enabled to set at rest the disputed points respecting the architecture of the interior of the Parthenon.

The Electric Telegraphs of the United States extend to 1659 miles.

The Railway Monopoly.—A correspondent of the *Times*, under the signature "Cato," gives the following illustration of the effect of low fares. The charges on the Glasgow and Ayr line are—1st class, 1½d.; 2nd class, 1¼d.; 3rd class, ¾d. per mile. The returns last year were ninety thousand pounds, the expenses thirty-six thousand pounds, leaving a profit of fifty-four thousand pounds, or nearly *sixty per cent. of the gross returns!*

The London and North Western Company are about to carry the mail to between London and Liverpool in five hours, including stoppages.

The Doncaster Station of the Great Northern Railway will, with necessary buildings and premises, occupy 35 acres.

Brighton to Havre.—Great efforts are about to be made to effect rapid communication between these towns. Under the auspices of the Rouen and Brighton Railway Companies, it is proposed to deepen the harbour at Havre, and to construct a floating breakwater off Brighton Pier. When these works are completed it is expected that passengers will be able to embark and disembark at all states of the tide and wind; and the journey from Paris to London will occupy 12 hours.

The Folkestone Pier progresses rapidly.

The Portland Breakwater.—Active preparations are being made for the commencement of the works, and the transmission of materials.

The Works at Devonport are carried on with great activity. There will be two basins, each 625 feet long; two docks, 309 feet long; another dock, 406 feet long; and a factory, 800 feet by 320 feet.

The Gas Companies at Bristol have reduced the price of gas to 6s. per 1,000 cubic feet.

Glastonbury Market Cross is completed.

The Manchester Parks appear to have cost 30,000*l.*

Rouen Railway.—The commission appointed to investigate the accident from the use of liquid hydrogen gas to light the Post-office carriage have reported thereon, the continued use of that method of lighting will probably lead to frequent explosions.

Draw-Bridge on the Brighton and Hastings Line.—There is a draw-bridge on this line, near Lewes, similar to that over the Arun, described Vol. VIII., p. 269. An engine-driver, a few weeks ago, mistaking, or neglecting the signal to stop, endeavoured to cross the river when the bridge was drawn back, and, consequently, drove the engine into the water. No one was injured.

The Brighton Railway Company intend to run express trains to London in one hour and a quarter, instead of one hour and a half, as heretofore.

The New Guildhall at Bristol is in the late Tudor style. The front is built of Bath stone and elaborately ornamented; but the building is said to be ill-ventilated and ill-lighted. Mr Pope is the architect.

St. James's, Bristol, is being restored under the direction of Mr. Fripp. The ancient architecture is chiefly Norman, and the architect appears to be treating it in a very unceremonious manner. He has removed an ancient piscina to make way for an arcade at the east end, of his own design, and some of the pillars which have swerved from the perpendicular he has coated with plaster to make them *look straight*.

Museum of Economic Geology.—A site has been prepared for the new building by pulling down some houses in Piccadilly, near St. James's church; but there are great complaints of the dilatory manner in which the works proceed.

Blackburn Exchange Buildings.—The competing designs having been examined by Mr. Cockerell, R.A., the first prize has been awarded to Messrs. Dickson and Brackspear; the second to Messrs. Bank and Clarke; the third to Mr. Wilson, of Bath.

The Liverpool Dock Works.—The expenditure for the year ending June 24, 1846, is £321,491 for new works.

Kemerton Church.—Archdeacon Thorpe's liberal offer to rebuild the north aisle and erect a spire, at the expense of £1,500, provided the parish would contribute £500, has been accepted by the parishioners after some opposition.

Government Offices, Whitehall.—The remains of the ancient chapel of Cardinal Wolsey are about to follow the fate of St. Stephen's Chapel. Is St. Margaret's Church to be the third sacrifice to the "Westminster Improvements"? Verily it becomes us well to sneer in the Nineteenth century at the iconoclastic fury of the Puritans! Had we less self-complacency in comparing our architecture with that of our ancestors, the following quotation from a recent number of the *Builder*, might be listened to.—"The recommendation of a select committee to remove St. Margaret's Church we protest against strenuously; restore it—improve it—make it a fitting adjunct to the neighbouring buildings, but don't think of destroying it.

The Academie des Beaux-Arts at Paris lately awarded the prizes of architecture. The subject proposed for competition was the construction of a Museum of Natural History. The successful candidates were—first, M. Normand, 24 years; second, M. Monge, 25 years; and, third, M. Ponthieu, 29 years of age.

Manchester Soirée.—The Manchester annual *soirée* this month, with Lord Morpeth in the chair, boasts of an attractive platform assemblage, whose names and eloquence will, no doubt, crowd the spacious rooms, and bring fruitful contributions to encourage the worthily ambitious literature of this populous place.

Wellington Statue.—Mr. C. R. Cockerell, R.A., the architect, has addressed a letter to the *Times*, on the subject of this statue, and added, "one more voice to the outcry already so justly raised against the erection of the statue on the arch at Hyde Park corner." He calls it a solecism in art, seriously involving the honour of the country. "The solecism consists," he says, "in the proposition to place a statue of colossal dimensions as an ornament to a triumphal arch of disproportionate magnitude, so that the ornament and the principal are in danger of changing places, and the major may become the subordinate of the minor; and again, in proposing to place that ornament on an axis at right angles with that of the arch itself." An unparalleled hero, it is said, may have an unparalleled position; but in questions of this nature, he properly observes *we* naturally turn to classical examples. *We!* We wish the committee would! All Bellori's examples in his book on the triumphal arches of Rome are against this infatuated sub-committee; the architect of the arch, Mr. Decimus Burton himself, is against its being there; the artists, the journals, and the good sense of the country have denounced it. "Had the sub-committee condescended," he says, "to seek the advice of professional men, the disgrace they are preparing for themselves, and the trouble to the public in replacing this fine work in an accessable and proper site might have been spared."

New Harbour at Holyhead.—The obstacles which have hitherto prevented the commencement of the public works in this harbour, are now, it is said, entirely removed, and the works are to be immediately begun. Captain Beechey, of the surveying steamer the Firefly, with the assistance of Mr. Rendell, and a number of divers from Portsmouth, made a most minute survey of the sea ground (that is to form the harbour; which has proved to be equal to that of any harbour in the kingdom. Hitherto an opinion was entertained by many nautical men that it would always be a dangerous harbour, on account of the supposed rocky nature of its anchorage; but the present survey has dissipated this idea; for, with the exception of one or two small insignificant rocks, there is excellent holding ground within the entire space to be inclosed for the new harbour.

At the Academie of Sciences, Paris, a paper from M. Jobard was received on the Chinese system of boring wells by means of a rope instead of metallic rods. He states that M. Goublet-Collet has adopted this system with the best results in Champagne; and that the cost is only 3 fr. per foot, without any increase according to depth. The whole of the apparatus costs only 500 fr.—B. Biot, in his own name and in those of Messrs. Bahioet and Pouillet, read a favourable report on an apparatus, constructed by M. Rumkorff, to facilitate the exhibition of the optical phenomena produced by transparent bodies when they are placed between the opposite poles of a magnet of great power.

*Paris Academy of Sciences.—Sept.*14.—A communication was received from Mr. Morse, giving an account of the extent of the telegraphic lines already established in the United States of America. It is as follows:—

	Miles.
Albany to Buffalo	350
New York to Boston	220
Do. to Albany	150
Do. to Washington	230
Washington to Baltimore	40
Baltimore to Philadelphia	97
Philadelphia to New York	88
New York to Newhaven	84
Newhaven to Hartford	30
Hartford to Springfield	20
Springfield to Boston	98
Albany to Rochester	252
Total	1659

Mr. Morse states, in his letter, that the electric telegraph is now the chief mode of transmitting all the news of the Government and the important correspondence of merchants and of the public generally. Its influence has, he says, been already felt by the press. The journals of the large towns, which were taken in the country on account of their giving the most recent news, have lost a great number of their subscribers; whilst there has been a very large increase in the circulation of the journals of the small towns near the extreme points of the electric telegraphs.

New Volcano.—A letter, dated Aug. 14th, from Lieut. Barker, of the East India Company's steamer Victoria, states, that on that day smoke was observed to issue from the summit of Saddle Island, lat. 15° 7′ N., long. 42° 12′ E. The account adds: "The weather at the time was very squally, with thunder and lightning. Saddle Island is one of a group called Zebayer Islands, in the Red Sea, in the direct track of vessels proceeding up and down, and are all of volcanic origin; but there is neither record nor tradition of their having been in active operation. Jibble Seer, in lat. 15° 32′ N., and long. 41° 55′ E., was observed to be smoking when visited by the officers of the Benares during the survey of the Red Sea, but never since. There is a tradition among the Arab pilots of its having been on fire some fifty years ago, and it bears among many of them the name of Jibble Dookhan or Hill of Smoke, and has the appearance of having been in active operation at a much later period than the Zebayer Islands."

The "Great Western" Locomotive is taken off the line to be repaired, though it has been but a short time in use.

The "Great Britain" Steam-ship has gone ashore off Ireland. All the passengers were rescued.

The Marley Tunnel, South Devon Line.—Fifty yards have fallen in, and four men have been killed by the accident.

Newcastle and Berwick Railway will consist of six arches of 125 feet span. The quantity of iron required is 6,000 tons.

On the Glasgow and Greenock Railway, 3rd class passengers pay one farthing per mile.

Ipswich and Bury Line.—The embankments on the Stowmarket Marsh have sunk into the morass (which is 80 feet deep), and disappeared.

St. Mary's, Truro.—Some time back, the pillars of the chancel were restored by the vicar. The effect was so good, that several parishioners undertook to restore each one pillar of the nave. The improvements are very encouraging.

All Saints, Wigan.—Very extensive repairs are in progress. The architecture is Perpendicular.

Holy Trinity, Hull.—This noble church has been the subject of a costly renovation. The capitals of the pillars are gilded, the ceiling is coloured blue with stars of gold, and new church furniture has been provided,

St. John's Gate, Clerkenwell.—The reparation progresses slowly. All that the funds suffice for is the rebuilding the parapets in brickwork, and pointing the stonework where it is not too much decayed.

Whitfield, in Glossop.—A new church in the Early English style is nearly completed: it has a lofty enriched steeple.

The New Music Hall, in Liverpool, has been commenced. It is to be in the Italian style, and will contain 2,300 people. Mr. Cunningham is the architect.

Manchester.—The Infirmary is enlarged. Two large Catholic churches are being built.

The Brussels and Antwerp Telegraph is open to the public. The charges are, for communicating from 1 to 20 words, *five francs*; reply, *one penny*; sending it to the residence of the inquirer, *five pence*. In England the charges are from twelve to twenty times dearer. How much better (is the old remark) do they manage these things on the Continent! But John Bull has plenty of money, and can afford to spend it. On all the lines terminating in London five shillings is the *lowest* charge for a telegraphic message; and 8d. per mile is usually charged for sending a porter to communicate the message in any part of London.

NOTES ON FOREIGN WORKS.

The Water-cities of China.—The French commissioners lately returned from that country, have added much to our present knowledge of those curious habitations of the Chinese. That country is literally paved with human beings, hence great numbers have chosen the waters for an abode—their they are born, live, and die. Canton, for example, has a floating city on the Tchou-Kiang. Eighty thousand barges are there at anchor, and form regular districts and streets. Allowing to each barge only ten inhabitants, which is surely not enough in a country where families are very numerous, this river-city will have a population of nearly a million of souls. The cities in the interior resemble rather ants' nests than any thing else. The wonder of all is the city of Sou-tchou, on the Imperial Lake, 180 miles from the sea, with which it communicates by a marine canal, accessible to the largest vessels. M. Hedde, one of the commissioners, has visited it, and states the number of its inhabitants at twenty-five millions (?) Of these, ten millions live on the waters—viz., in the port and the canals of the city. Up to a certain age, the children in these water-cities have a sort of wooden buoy attached to their shoulder, which preserves them if they fall in the water. Not only men, but even animals live on these barges, and ducks, to an enormous extent, fill up the decks and holds of barges and vessels.

Panoramas of the Principal Cities of Russia.—The attention of the people of Moscow had been attracted, during the summers of 1844 and 1845, towards a person, who every day established himself on the platform of the steeple of Ivan-Veliki, and remained there until sun-set. This height commands a view of the holy city and fifteen leagues around it. They knew, in fine, that this curious personage was M. Acaric Baron, a French artist, who painted a panorama of the old city of the Czars. The higher classes of Moscow thus took an interest in the artist. Such was the renown of his praeverance and skill, that the Emperor wanted to see him, and M. Acaric-Baron received orders, as soon as his beautiful cartoons were completed, to repair to St. Petersburg. His Majesty, after the inspection of the work, ordered that the panorama of Moscow should be placed in one of the rooms of the Imperial palace. M. Acaric obtained, moreover, permission to publish his work on stone, and the Emperor and Prince Leuchtenberg headed the list of subscribers. It is now spoken of, that M. Acaric will receive commands to paint the panorama of St. Petersburg and the other large cities of Russia.

Art in Italy.—The Italian Academies, like those of other countries, lay under the imputation (right or wrong, we shall not decide), that the truly vivifying and pregnant spirit has departed from them. It is to be taken into account, however, that while all other instructional institutions aim only at the affording of the *current* stock of knowledge and acquirements, art-academies, on the other hand, are only then praised, if they have produced extraordinary talents. More than ever, Italy is engaged in the exploration of her subterranean treasures; and soon, the art-specimens of her old inhabitants—the Etruscans and others—will cover the presses and tables of our museums. As to the general mode of exhibition, we may rejoice at the greater adherence to historical arrangement now generally resorted to; while, on the other hand, those merely arbitrary shiftings of the specimens of art in the Vatican, or the pasting of a row of tickets on them (requiring the constant purchase of new catalogues), as has been done at Naples, are far from being commendable. Even the, perhaps well-intentioned, transposition of the antiques in the Villa Albani inspires us with grief, when we think that the former arrangement had originated with Winkelmann. The picture galleries of Italy lose, at times, by the circumrotation of men's fortunes, their fairest gems; and thus that splendid picture of Francesco Francia, of the Ercolani Palace at Bologna, has gone to Russia. Others, however, refuse any offer, as for instance, the Duke of Terranuova, in Naples, who praises his Holy Family, by Raphael, painted for one of his ancestors, like a family relic. On the other hand, many hitherto forgotten or buried pictorial treasures are brought to light, as, for instance, the paintings of Gritto at Florence, in the Bargello, or the Last Supper of Raphael in the convent of St. Onofrio delle Monache, in the same city. Collections which, hitherto, were scarcely considered of any note, like the Royal Palace at Turin, are better known and appreciated, and at Rome a new one has sprung up, which has made a splendid beginning, with the acquisition of the great Altar piece of Filippo Lippi. In several galleries the lighting from above has been introduced; if, however, this is not done efficiently, it will always be unsatisfactory, especially were pictures of small size are to be viewed. Moreover, such a *half-light* from above will make pictures appear in another light than that in which they were painted, and in which the artist intended them to be seen.

Late Excavations in Italy.—M. Alessandro François, known by his former sucesses in the above enterprise, has began of late some excavations at Chinsi, in the so-called Nun's bush, and his tact is so correct, that after he had traced his lines, by the work of only six excavators, after the short space of two hours, the vestiges of an ancient tomb were found. Further exertions laid open the row of tombs, which led to the subterranean chamber. To penetrate, however, to this, full six days of incessant labour were required, as the Hypogœum lay at a tremendous depth. This consists of three rather large rooms, of which the first is adorned with wall-pictures. Two, however, only have been preserved. One represents a chase—two men and a dog pursuing a hare. The other consists of two persons, who are received by another, sitting, with a certain air of solemnity. A flute player stands beside them. The pictures are made in an exceedingly delicate and free manner. In the middle of the first tomb there are also paintings—viz., two red tents, whose ends are extended by two genii. The pictures of the ceiling are in a perfect state of preservation, being red *cassetons* with a dark border. The minor contents of these tombs were also interesting, as besides several *pateræ* with charming designs, fragments of works in bronze and gold, and a very fine vase of *Olerite* with fine relievo designs, were discovered. The Princess of Canino continues to explore the environs of Civita Vechia, the ancient city of the Vulci. They have been resumed this year near Ponte Rotto, on the banks of the Fiora—the locality where, last year, the fragments of some splendid bronze chariots were discovered. The worknen have this time found a large sepulchral chamber, in which two huge sarcophagi were met with. The one is of that rock called *nenfro*, and the other of marble, or rather alabaster—the latter being ten yards long, and on the lid are two figures of natural size. The main tomb is covered all around with basso-relievos of fine design, well preserved. They represent scenes of combats, and also some of those figures, often to be met with, where bulls are delaniated by lions and griffins. On the upper rim is an Etruscan inscription! Such sarcophagi have never before been found at Vulci. Very interesting and extraordinary is the following: It has been found here, that in the walls on which sepulchral vases have been, most probably, placed in the time of the Romans, fragments of vases with very fine designs had been used as an admixture of the *cement* or *mortar* of the walls. It is obvious, that at a period when such could have been done, the value and estimation of these Etruscan vases must, for some reason or other, have been completly exploded.

The Donau-Main Canal.—The Monument.—This great undertaking, uniting (at least, for smaller craft) the German Ocean with the Black Sea—projected by Charlemagne and carried out by Lewis of Bavaria—has been fully concluded by the erection of a monument at the place where its construction had been the most difficult and expensive—the Burgberg, near Erlangen. The canal had to pass close to the banks of the Regnitz, between two vertical walls, whose distance is 24 feet, and which are, at some places, 30 feet high. For the sake of widening the space taken up by the Bamberg-Nüremberg road, it had to be extended in the direction of the canal, part of the Burgberg to be cut, and the considerable terraces protected by walls, rising in several stories. The space between Erlangen and the Burgberg, about 4,000 feet in length, occasioned considerable trouble and expense, as a dyke 2,100 feet long, and of an average height of 15 feet, had to be made up to the banks of the Swabach. This dyke is protected by a wall 1,500 feet long, which, like some Roman structures of the kind, is dressed with hewn stones. On this spot the monument is erected, whose foundation consists of blocks from the quarries of Kehlheim, some weighing 25 tons. It is Schwanthaler who made the designs, executed by some of his best pupils. The material selected for the four statues is also the splendid Jura-limestone of Kehlheim, and they were cut out, in their rough state, in the quarry itself, as the block for the statue of the Danube alone weighs 40 tons. The two reclining statues are 17 feet, and the two standing ones 14 feet, in length. The execution of this work occupied four years, and it was though fit that they should be first objects to be conveyed on the canal, along its whole extent, from Kehlheim to Bamberg. The monument is 48 feet high and 42 feet broad, and its basement bears the following inscription in bronze: "Donau and Main—für die Schiffarth verbunden—ein Werk von Karl dem Grossen versucht, durch Ludwig I., König von Bayern neubegonnen und vollendet." Beside this inscription is a bronze trident and an oar, adorned with wreaths. At the base, a copious stream of water issues from a bronze lion's head. The statue of the Rhine represents a vigorous man, whose upper part is uncovered, and exhibits a powerful, manly chest; the features are stern, and the head, adorned with garlands of vine, is turned towards that of the Danube, represented under the form of a virgin, reclining in placid repose. Commerce and Industry are reptesented by two other female figures. The whole appearance of the monument, whose background is formed by a somewhat receding mountain covered with oak trees, is imposing and noble.—And to show, in fine, that it is understood now on all hands, that industry, commerce, and the arts can never exist isolatedly to any perfection, the die-siker of the king, M. Neuss, of Augsburg, has executed a fine medal tn commemoration of the above great achievement for the communication of middle Europe.

Panama Canal.—The French *Moniteur* states, that the proceedings between the French-English Company for the canalizing of the straits of Panama and the government of New Grenada, have arrived at that point, that nothing but some minor matters remain to be settled. It was M. Klein, agent to the Company, who had negotiated at Bagota with the President of New Grenada.

Effects of the late Earthquake in Italy.—A great many scaffoldings yet to be seen in the streets of Leghorn, attest the severity of the shocks; and the damage caused in that city alone is valued at two millions of livres. In Pisa it was necessary to demolish whole houses.

A whole Mountain of Grecian Antiquities to be Purchased!—A German traveller in Asia Minor seriously puts forth the suggestion, for any friend of antiquities to purchase the mount near Priene, on the banks of the Meander. On the plateau of the hill lay a world of ruins of the old show-buildings, amongst which are the huge ruins of the famous temple of Athene. Our informant says, that with two thousand dollars, a mountain of, columns, marble slabs, frieses, &c., could be acquired.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM AUGUST 25, 1846, TO SEPTEMBER 24, 1846.

Six Months allowed for Enrolment, unless otherwise expressed.

Alfred Krupp, principal of the house of Frederick Krupp, of Essen, Prussia, but now of Leicester-square, for "certain Improvements in the manufacture of spoons, forks, and other similar wares, and in the machinery, or apparatus, employed therein, parts of which are also applicable to other manufacturing processes."—Sealed August 26.

Thomas Wroughton, of Eltham place, Kennington, gentleman, for "certain Improvements in apparatus and instruments for ventilation and respiration."—August 26.

Henry Bessemer, of Baxter-house, Old St. Pancras road, engineer, "certain Improvements in railway engines and carriages, parts of which improvements are applicable to the propelling of steam vessels, and to motive purposes generally."—August 26.

Richard Clarke Burleigh, of Bath, gentleman, for "certain Improvements in artificial light."—August 28.

Arthur Howe Holdsworth, of Brookhill, Dartmouth, Devon, Esq., for "Improvements in buoys and giving buoyancy to boats."—August 29.

James Boydell, of Oak-farm-works, near Dudley, ironmaster, for "Improvements in applying apparatus to carriages to facilitate the draught."—August 29.

William Air Forster, of Glasgow, leather merchant and boot maker, for "an Improved mode of making belts for driving machinery, traces, reins, and other articles of leather, felt, or parchment, and for an improved apparatus or machinery for the same."—August 29.

Alexander Debain, manufacturer, of Paris, France, for "certain Improvements applicable to keyed musical instruments."—August 29.

James Roose, of Darleston, Stafford, tube manufacturer, for "Improvements in the manufacture of welded iron tubes."—August 29.

Henry Henson, of Hampstead, Middlesex, gentleman, for "certain Improvements in railways, and in railway carriages, having for their object the better accommodation and security of the public."—August 31.

James Warren, of Montague-terrace, Mile-end-road, gentleman, for "Improvements in the manufacture of cast screws."—August 31.

Frederick Henry West, of the City-road, Middlesex, gentlemen, for "certain Improvements in securing corks in bottles, jars, and other vessels to contain liquids and other matters, and also improvements in such bottles and other vessels."—August 31.

Nicholas Harvey, of Hayle Foundry, St. Erth, Cornwall, for "certain Improvements in filtering of water for steam engines and boilers."—Sept. 3.

James Coles, of Harley-street, Cavendish-square, Middlesex, surgeon, for "Improvements in apparatus for the prevention and treatment of distortions of the spine and chest, also for treatment of diseases of the spine and other disorders where a recumbent position of the patient is required."—September 3.

George Senior, of Bradford, York, gentleman, for "certain Improvements in washing cleansing, scouring, and bleaching silk, cotton, wool, and fibrous substances generally, also in dyeing, combing, carding, spinning, felting, milling, or otherwise treating or preparing fibrous substances generally."—September 3.

Peter Armand Leconte de Fontainmoreau, of New Broad-street, London, for "certain Improvements in the machines for the manufacture of bricks and other plastic products;" being a communication from a foreigner residing abroad.—September 3.

Charles Ylery, of Rue St. Lasare, Paris, France, engineer, for "Improvements in ascertaining and regulating the speeds and times of railway trains."—September 10.

Moses Poole, London, gentleman, for "Improvements in treating vegetable fibres to render them applicable to the manufacture of paper." (Being a communication.)—September 10.

Charles Richardson, of Dalston, Middlesex, gentleman, for "certain Improvements in making and refining of sugar, and in the machinery and appartus employed therein." (Being a communication.)—September 10.

David Davies, of Wigmore-street, Cavendish-square, Middlesex, for "certain Improvements in steps for carriages and other purposes."—September 17.

Richard Ford Sturges, of Birmingham, Britannia ware manufacturer, for "Improvements in filtering apparatus, and in apparatus for making tea-pots, and other vessels of metal."—September 17.

James William Bowman, of Great Alie-street, Middlesex, for "Improvements in reburning animal charcoal."—September 17.

William Palmer, of Sutton-street, Clerkenwell, manufacturer, for "Improvements in the manufacture of lamps and candlesticks, and in gas and other pillars and pipes."—September 17.

Henry Franklin, of Marstone Mortaine, Bedfordshire, for "Improvements in the manufacture of bricks, tiles, and other like articles."—September 17.

Frederick Brown, of Luton, Bedfordshire, ironmonger, for "Improvements in ovens for kitchen-ranges."—September 17.

William Edward Newton, of 66, Chancery-lane, for "Improvements in preserving fruit and vegetables."—September 17.—(A communication.)

Henry Wrigg, of Upper Holloway, Middlesex, civil engineer, for "certain Improved means or methods of diminishing draught and friction in carriages and other conveyances."—September 17.

James Lamb, of Canal Road, Kingsland-road, for "Improvements in the manufacture of clogs."—September 24.

Alfred Vincent Newton, of Chancery-lane, for "Improvements in the method of hardening and tempering various articles made of steel, or of iron and steel combined;" being a communication.—September 24.

Henry Deacon, of Eccleston, Lancashire, engineer, for "Improvements in the construction of flattening kilns."—September 24.

Charles Fox, of London Works, near Birmingham, engineer, for "Improved machinery for shearing, cutting, and punching metals."—September 24.

Charles Chinnock, of Seymour-place, Little Chelsea, for "Improvements in folding and securing letters, envelopes, and covers."—September 24.

Edmund Nevot, of Lombard-street, gentleman, for "Improvements in the manufacture of paper, being a communication."—September 24.

Peter Armand Lecomte de Fontainmoreau, of No. 15, New Broad-street, city, for an "Improvement or Improvements in the mode of manufacturing corks," being a communication.—September 24.

CORRESPONDENTS.

Next month will be noticed "Peschel's Elements of Physics," "Castle's Surveying," "Mullins on Peat Bog, and the construction of Roads, Railways, and Canals in Bog," and a Tract by Sir Howard Douglas, entitled, "A Reply to some Observations in a review of the pamphlet entitled, Metropolitan Bridges and Westminster Improvements in the *Civil Engineer and Architect's Journal*, September 1846."

ERRATUM.—The last sentence on page 306 is editorial, and does not belong to Mr. Roberts's remarks. It belongs to the next paragraph.

TRABEATE AND ARCUATE ARCHITECTURE.

The adoption of technical terms in any art usually results from a sacrifice of one or other of the two essential requisites of a perfect nomenclature—perspicuity and conciseness. A new compendious term which supplies the place of a long periphrasis affords to the initiated the advantage of brevity—while to the uninitiated it is liable to appear pedantic and obscure. So that the addition to the list of technicalities of an art already containing a large number of them should not be made except where the new term supplies the place of long and continually recurring phrases, and is of itself sufficiently significant to be remembered without difficulty.

Now, in developing the principles of constructive architecture, we are constantly presented with this fact—that the architecture of every age and country of the world is separated as regards mechanical structure into two classes—that in which the masonry sustains vertical pressures only, and that in which both vertical and lateral pressures are sustained. The former consists of horizontal entablatures supported by vertical imposts, unjointed blocks or architraves resting at their ends on piers, and rectangular frame-work formed of transverse beams or joists sustained by upright timbers. In the other great division are contained all structures in which the intervals between two piers, columns, or abutments, or between the sides of an embrasure or other opening in a wall, are spanned by an arch consisting of many stones so shaped and united as to be capable of resisting the pressure of superincumbent weights. In the science of Mechanics the principles of these two methods of construction are distinguished thus—in the first method—that in which spaces are spanned by one single block or beam, the material is influenced by two equal and opposite forces of tension and compression—in the latter method where spaces are spanned by more than one block, the internal forces of the material are generally of the nature of compression only, but there are moreover lateral forces external to the system, exerting outward thursts or pressures which must be sustained by external appliances.

It is immediately obvious that these different mechanical principles must, where the decoration is dependent on the construction, produce altogether different architectural forms. Where the embrasures or intercolumniation are spanned by a single block, the difficulty of procuring single blocks of great length will render it necessary that the piers or columns should be comparatively close together, and as the pressures are wholly vertical, the only requisite for strength is that the columns be not crushed by the weight on them, and no great precautions need be taken to prevent them from being overturned by lateral pressures. Consequently, in the one mode the columns will be of nearly uniform thickness throughout their height, and the intercolumniations will be narrow: in the other mode, the intercolumniation may be increased and the piers will have enlarged bases.

These considerations in their utmost generality, distinguish all architecture into two grand classes: and when we regard the value and exceeding comprehensiveness of the classification, it does not seem unreasonable to demand that distinctive appellations should be appropriated to it, and be received among the recognised terms of architectural nomenclature. For the names of the two classes no words seem more natural than those contained in the title of the present paper, and accordingly we assume that all architecture is divided into two kinds—Trabeate and Arcuate.

Trabeate architecture is the most ancient. Very little reflection will show that a system of construction, identical with that of the primitive timber hut, would be the earliest adopted, and that the arch, a structure requiring much mechanical skill in the workman, and much theoretical, or at least experimental, knowledge in the architect, would be one of the appliances of later art. The early history of the arch is very obscure; it is however certain that neither Pelasgic, Babylonian, Egyptian, nor Grecian architecture present any trace of arcuate construction: the earliest examples which have had any important influence on modern art are certainly to be found among the Romans. The nature of this influence is admirably described in the following passages from Professor Willis's Architecture of the Middle Ages.

"After the arch and the vault had enabled the Romans to construct buildings with small materials, it is curious to observe the struggle by which the arch forced itself into the Decorative construction. At first, the arch is used sparingly, and only in cases of necessity. It is either hid under the plaster, or it is kept subservient and as if the architect were ashamed of it as a clumsy and economical expedient, all the resources of the Decorative construction are employed to *conceal* the important place it holds in the mechanical structure of the building. Gradually we find the vault first, and then the arch, assuming a more prominent place only to produce *that discordant effect which must ever result from the attempt to harmonise two contending principles.*

"For when the arch is employed, the diagonal strains must be provided for; and as the Decorative system of the Greeks was founded upon a mechanical structure that only exerts perpendicular pressures, it is clear that the diagonal ones must be concealed by huge rectangular masses, decorated so as to appear as if sustaining vertical pressures only, unless we choose to invent new forms for the diagonal props. The Romans attempted concealment, and hence introduced discordance between the decoration and mechanism of the structure. The Gothic builders, in later times, more wisely adapted their decoration to the exact direction of the forces required by the vaulted structure."—p. 17.

Every word of this extract demands the most attentive consideration. No other comment is here requisite than the citation of a few instances of that violation of the principles of faithful architecture which the Romans exhibited in their attempts to combine arcuate with trabeate construction. In the Coliseum the weight of each story is in reality sustained by tiers of arches: in addition to these, however, there are entablatures between the stories which, as well the columns between the arches, are merely affixed to the building for show, and have no constructive purpose. The same remark applies to the Triumphal arches, one and all: and these moreover involve the additional solecism of being treated not as members of a building, but as integral buildings of themselves—they have all the strength and solidity requisite for sustaining an immense superstructure, but like the monumental columns known by the names of Pompey and Trajan, are isolated and sustain nothing but their own mass, or at most that of statues of which the weight is ridiculously disproportionate to the solidity of the supports. This species of solecism has found great favour in our own country, and is exhibited on a large scale in the Barriere de l'Etoile, at Paris.

Much, however, of the architecture of the Romans was free from the incongruity described by Professor Willis, and even where it exists there is frequently discernible in spite of it (not in consequence of it), great beauty and pictorial effect, which cannot be overlooked without an intolerant adherence to systematic principles. It will, however, be our business to show hereafter that the Romans *gained* nothing by this sacrifice of purity and harmony—that equal vigour, variety, and depth of shadow may be attained without violating the principles of constructive decoration which were observed in Greek and Pointed architecture.

The opinion of the authority cited above is confirmed (with a modification similar to that which we have just suggested,) by Professor Whewell, who, in his "Notes on German Churches," speaks of "the Roman introduction of the arch into Grecian architecture" as follows:—

"In this manner, then, were produced two planes of decoration; one consisting of the traditional scheme of the structure; the other, behind it, containing the real construction—the arch and the impost mouldings. And though this combination is, in reality, *incongruous and inevitably transitional*, it would be impossible for a genuine artist not to perceive that it disclosed an extraordinary richness and depth of effect."—p. 8.

Again,—

"The introduction of the arch undermined the Grecian system of entablature, and introduced a double plane of decoration: the ruin of art and taste supervening on this, broke up still further the Roman traditional arrangement; caprice and the love of novelty introduced new forms of members and ornaments into this incoherent mass: arches, of various shapes, were invented or borrowed; the Byzantine dome was added to the previous forms of Roman vaulting. So far, all is a proof of disorganisation. But then comes in a new principle of connexion first, and unity afterwards. The lines of pressure are made prominent features; the compounded arches are distributed to their props; the vaults are supported by ribs; the ribs by vaulting shafts; the upright meeting of the end and side is allowed; the structure is distributed into compartments according to such lines, each of these being symmetrical in itself."—p. 15.

If the admirers of Precedent, those who confound antiquity and excellence as essentially synonomous, feel unwilling to admit the authority of two eminent writers who characterise a large part of Roman architecture, the one as discordant and dishonest, the other as incongruous and inevitably transitional, let them reflect that the Romans were, until the time of their emperors, so constantly engaged in foreign or domestic wars, that they had little opportunity for cultivating the arts of peace, even if they had not lacked the desire and capacity; that they never exhibited that pure love and vivid perception of the Beautiful which essentially characterised the Greek race; and, above all, that the Fine Arts were not indigenous with them, but imported—imported, moreover, as the exotic productions of a tributary province. The previous education of the Romans by no means qualified them for a comprehension of the subtle principles of Greek art; and when we consider that they appropriated its splendid results with no patriotic enthusiasm for them—with no higher feeling, indeed, than the love of luxury and the ostentatious magnificence natural to victorious invaders—it is scarcely to be wondered at that they misunderstood the spirit in which their glorious spoils had been designed. In a word, the Romans not only laid no claim to the artistic feeling of the Greeks, but actually boasted of the opposite tendency of their national genius; and the greatest of their poets so describes them in a noble passage, in which his evident object is to paint the character of his countrymen in its fairest colours:—

"Others, I know, will more skilfully mould the breathing bronze and shape the life-like marble; others will excel in the arts of eloquence; or, by the aid of philosophy, mark out the pathways of heaven and tell the risings of the stars. But, Roman! take thou heed to rule nations by thy might! These shall be *thy* arts—to dictate terms of peace, to spare the submissive, and subjugate the proud."*

In pursuing historically the development of arcuate construction, the next period of its progress is that subsequent to the destruction of the Roman Empire in the West at the close of the fifth century. The change which architecture now experienced was not one of mere individual form, but one which effected a revolution in its fundamental principles, and led ultimately to the most extraordinary results, by entirely destroying the old classic forms and substituting altogether new kinds of architectural composition and detail. The changes which followed the fall of the Roman empire, though essentially similar throughout Europe, assumed two different forms of expression in the North and South. To the Northern class belong the Norman of our own country, the Romanesque of France and Germany; to the Southern, the Lombardic style of Italy and Moresque of Spain. These two classes, though originating in the same type, never amalgamated at any subsequent period of the art. They possess, however, certain grand features in common, which distinguish them from their Roman model, and are especially to be noted as the real causes of the total change of art which ultimately ensued. The grand innovations of the Byzantine period were, then, the ostensible use of buttresses and the employment of columns to support arches springing directly from their capitals. Architecture continued, however, to exhibit the discordance between arcuation and trabeation: the style every where manifests itself as transitional and imperfect—and these evident marks of transition, it may be observed parenthetically, are of themselves sufficient objection to the modern imitation of Norman or Romanesque architecture. The buttresses of buildings of that period never possessed any great solidity; the lateral thrusts of the arch were chiefly resisted by the enormous thickness of the walls, Still a new and fruitful principle had been introduced—that of applying members for the exclusive purpose of resisting horizontal strains. The springing of the arch, also, directly from the pillars, led to greatly increased freedom of construction;—the architect was thereby enabled to get rid of the straight entablature, which had been a source of constant difficulty and restraint by giving to buildings a horizontal regularity, which, combined with the verticality of successive stories, confined the architect to what may be loosely termed a *reticulated* mode of construction. It is obvious, therefore, that until the arch was allowed to spring immediately from the columns, it would be impossible to build edifices possessing the diversity of form exhibited in the Cathedrals of Spires, Mayence, or Peterborough, or the church of St. Martin, at Cologne.

It will be seen, therefore, that the change introduced into the architecture of this period was a great step in the progress of arcuate construction towards its complete development; and although the contest between the arch and entablature was not yet won, the *casus belli*—the real discordance between the two principles—had received practically an accurate definition. The entablature still appeared, but was no longer sustained upon columns. Where it existed, it was either supported by arches or else was purely adscititious—that is, was simply affixed to the building for ornament, without any constructive purpose. Nor was it the only member of the architecture of this period which was treated thus inartistically: arches of decoration, corbel-tables, &c., were frequently introduced, not constructively, but merely as clumsy contrivances for giving variety to the surface of the masonry. It is an important practical observation respecting all mixed styles such as the Roman, Romanesque, and modern Mongrel Classic, that they necessitate the employment of adscititious ornaments to conceal the mechanical structure of the architecture.

Romanesque architecture—taking the term Romanesque in its most extended sense—may be considered to have lasted seven hundred years—that is, to the end of the 12th century. At that time, another great change took place in European architecture—the introduction of the *ogival primitif* of France and the Early English or Lancet style here. The great *formal* distinction between this style and the preceding is undoubtedly the introduction of the Pointed arch. But our present object is to trace not so much the changes of form, as those of construction which characterise successive styles. Restricting ourselves to this branch of the subject, we find the chief importance of the Pointed arch to consist in the lightness and loftiness of the structures in which it is employed. By known mechanical principles it may be shown that, *cœteris paribus*, the lateral thrust of an arch is diminished as the rise, or height of the crown above the springing, is increased. If, for instance, two arches, which sustain equal loads, are of equal span, and resemble each other in all other respects except their rise, be compared, the flattest arch will exert the greatest horizontal thrust. Now, in the semicircular arch the rise could not exceed half the span—in the Pointed arch, the rise was increased frequently three-fold, and occasionally four-fold. It will be seen, therefore, that in the new style the necessity of resisting lateral pressure would be greatly diminished, and accordingly the piers and abutments are found to be much less massive. The facility of sustaining great weights without cumbrous piles of masonry at their bases, lead to the adoption of that glorious characteristic of Christian architecture—the Spire; a member which the perversity of modern debased architecture has applied to buildings in which it necessitates incongruity or concealment of the mechanical construction.

Another important innovation of the Lancet style was the increased breadth of the buttresses. This change may at first seem inconsistent with the diminution of the lateral pressures of the arches; but it is to be remembered that in the preceding style, these pressures were resisted not by buttresses so much as by continuous walls of enormous thickness; and that in this style the thickness of the walls was greatly diminished. So that in the Lancet style, in fact, the appliances for resisting lateral pressures were not increased, but merely rendered more apparent. In the Norman style the whole wall formed one continuous buttress; in the new style this continuity was broken—the buttresses were put just where they were wanted, and no where else. Moreover, the form of this buttress was greatly improved: instead of being of a uniform height from the base to the summit (like the continuous wall) it became *tabulated*—that is, diminished by stages. To refer again to mechanical principles, we see how great an advantage was here gained. The mechanical requisites of a buttress are that the "line of pressure" should fall within the buttress in every part of it; so that provided the base be sufficiently broad and the diminution of the breadth of the buttress from below upwards be not too rapid, all the strength of a uniform structure is attained. The new form of the buttress, therefore, effects a vast saving of superfluous material, and, therefore, a great increase of architectural beauty.

No generic changes of arcuate construction were made subsequently to those described. The succeeding style (the Decorated of this country) introduced great variety and complexity of form, and the traces of the entablature are still fainter than in Early English. Still, considered constructively, the arch and its appliances remained unaltered. In the third style, however, the arch becomes far less acute than before. It is curious to notice in this, as in many other cases, the recurring cycle of variations, which seems to be a law of art. The first innovation of Pointed architecture was the lofty acute arch—now the arch becomes actually flatter than in the old Norman or Roman. As a necessary consequence, the piers and buttresses are increased in magnitude. We have now the piers of the nave of Winchester, the buttresses of King's College Chapel, and the flying buttresses of Westminster Hall.

The later Perpendicular exhibits in form, but not in reality, a return to the Trabeate system. Horizontal lines become more frequent than heretofore: but they are usually confined to surface-panelling, transom-bars, and similar details. They never exhibit themselves in true architraves, or single unjointed blocks. On the contrary, the extraordinary width now

* Excudent alii spirantia mollius æra,
Credo equidem: vivos ducent de marmore vultus;
Orabunt causas melius; cœlique meatus
Describent radio, et surgentia sidera dicent:
Tu regere imperio populos, Romane, memento.
Hæ tibi erunt artes; pacisque imponere morem,
Parcere subjectis et debellare superbos.—*Æn. vi. 847.*

given to arches and vaulting taxed to the utmost the resources of arcuate construction.

Then followed the decline of the arts. Pointed architecture became distinguished by conventionalism and over-refinement—the sure precursor of decay. Artistic feeling grew feebler and at last absolutely perished. A conclusive proof that it *had* perished, and that caprice had succeeded to its place was this—that men lost sight of architectural principles and cared only for architectural forms. There arose a strange classic mania, and, as might be expected in such an age, the classic forms were employed in utter ignorance or defiance of their right application. Every perversion and grotesque absurdity which empericism could invent or ignorance tolerate received sanction during the period styled the Revival. The confusion of arcuate and trabeate construction exhibited in Roman architecture was renewed in an aggravated form. Columns stilted to give them an undue height, their shafts deformed by square dies disposed at regular intervals, or channelled with sinuous lines in extravagant imitation of the natural roughness of unhewn stone were among the minor barbarisms. What shall we say of semblances of huge gables or pediments attached to the *internal* walls of buildings and ridiculous imitations of small gables arranged in rows on the external walls? Sometimes we find double pediments on the outlines of two gables represented in the surface of a wall by triangles set one immediately above the other. And sometimes we find portions of cornices cut away so as to leave a gap in the upper or lower part of the pediment; and at other times the pediment is polygonal or curvilinear, the curves having occasionally a contrary flexure. No amount of precedent would sanction these abuses which seemed to have been perpetrated for the express purpose of bringing the Classic forms into disgrace. Moreover, the weight of Precedent, if in this case it have any weight, is on our side, for it was the Revivalists, not we, who rejected its authority by appropiating the ancient forms to strange and novel uses.

It belongs immediately to the subject to observe that in the history of Art the decadence of constructive arts has generally been coeval with the advancement of the decorative. At the time when architecture has flourished, painting, sculpture, &c., have generally been neglected, and conversely. The noblest, purest, most faithful architecture which the world has seen since the Christian era, belongs undoubtedly to the age of Cologne Cathedral: and yet the uncouth forms of monumental brasses, wood carvings, and painted glass, of that age, are inartistic in the extreme. They are for the most part incorrect in drawing, shadow, or perspective; inaccurate in the anatomical forms and proportion, and manifest that stiffness and uncertainty in the use of the chisel and pencil which infallibly mark the first efforts of rude art. Monumental sculptures did indeed occasionally exhibit great merit, but these works are rare exceptions; and those of them which exist in our country seem to have been the productions of foreign artists. In proportion however as architecture progressed toward decay, the decorative arts established themselves on its ruins. The Chapel of Henry VII. at Westminster is filled with the most beautiful carving; and his tomb is one of the last and noblest productions of mediæval art. The painted windows of King's College Chapel have no parallel throughout the world for magnificence: executed probably after the completion of the building, they exhibit far higher merits than those of gorgeous colouring and minute workmanship. The composition and drawing of the east window in particular are wonderful proofs of the excellence to which the decorative arts had attained.

Of the era of Raphael it does not lie within the compass of our subject to say more than that the magnificence of its sculpture and painting presents a strange contrast to the impurity and incongruity of its architecture. Once, and once only, in the world's history, a Phidias and Ictinus appeared *together.*

The classic Revival affected England more slowly than the rest of Europe. Among a people, whose attachment to particular forms and customs is slowly contracted and long retained, an imported style of architecture would not easily find favour. Even after Pointed Architecture had died of old age, many of its forms were retained. The windows of the Debased Tudor style are mullioned and retain their hood mouldings. The Elizabethan frequently shows a great deal of constructive faithfulness and picturesque effect, and where it is tolerably free from classic details, presents much that is worthy of modern imitation.

There was a trabeate style which reached its greatest perfection in the reign of Elizabeth, which is to be noted as especially remarkable for its character and the time in which it appeared. We mean the timber framed architecture of the halls and manor-houses erected in this reign. This style is frequently exhibited in great magnificence in this country, and in parts of the continent, such as Belgium and Normandy, where timber is abundant. The cities of Ghent, Bruges, Rouen, &c, display beautiful specimens of street architecture, which put to shame our modern system of showy decoration. It seems singular that a style almost purely trabeate should have flourished at a time when great efforts were made to effect an incongrous adaptation of Classic forms to arcuate construction. Nor is it less remarkable that the timber-framed style should be so nearly faithful as it is. The gables are treated constructively as the ends of roofs, and where columns are used, they are generally used as supports. The fashion of affixing columns upon the faces of walls, where they appear as mere protuberances, was of later growth.

The Elizabethan and timber-framed were the last of the original styles. The houses of the period of Queen Anne have indeed a certain degree of character from the conspicuous use of the plate-band or straight arch in doors and windows. Still it may be considered with sufficient accuracy that no new species of construction was introduced subsequently to the reign of Elizabeth. Since that period architecture has consisted in the imitation of ancient styles and the reproduction of ancient forms.

We have therefore arrived at the conclusion of the historical portion of our subject. The application of the principles which distinguish arcuate and trabeate constructio to modern architecture, will be the subject of another paper. These principles have been so systematically violated during the last three centuries that great difference of opiuion will exist respecting their importance in architecture. The historical sketch here given may however be useful in indicating a plan for compiling an altogether new kind of History of Architecture. Numerous writers have already chronicled the successive changes of architectural forms—the history of Architectural Construction remains to be written.

CANDIDUS'S NOTE-BOOK.
FASCICULUS LXXI.

"I must have liberty
Withal, as large a charter as the winds,
To blow on whom I please."

I. Those who have suggested—altogether prematurely, it now seems—the Tudor style, for a new metropolitan royal residence in lieu of Buckingham Palace, have overlooked one or two objections that present themselves. In the first place, the Queen herself might wish for something altogether different from Windsor Castle,—for a "companion" or "*pendant*" to it, but distinct from it in character, and affording opportunity for exhibiting quite another mode of embellishment. In the next, were it to be at all similar in style to the "Palace of Westminster," immediate comparison between the two would be the consequence, and as it is not at all likely that a second palace would at all rival or approach Mr. Barry's edifice, in luxuriant ornateness, the comparison would hardly be to its advantage. Thirdly, domestic Tudor or Elizabethan are now so frequently employed for buildings, which however large they may be, are the reverse of palatial in purpose, that owing to the modern application of them those styles are now in some degree identified with hospitals and other public buildings of that class.

II. Surely it must have been said for Wilkie, since he himself could hardly have uttered such a piece of extravagance as to assert that, "what the tour of Europe is necessary to see elsewhere is now found congregated in the single city of Edinburgh!"—At any rate he could not have uttered any such arrant claptrap in his sober moments, for only the influence of "mountain dew" could have enabled him to find "the bays of Genoa and Naples, the Roman capitol, and the Grecian Acropolis, there realized." Pity! that he could not fancy Venice there also, and take St. George's church for another St. Mark's. If nature has been somewhat liberal towards the Northern capital by affording it a picturesque site, art has been stingy enough. The locality may be called romantic, but the architecture is shockingly prosaic. Scarcely a single edifice in the whole city can be quoted as a monument of art or superior taste, least of all those which have been erected for the nonce as "monuments," to wit, the Nelson one—a thing so truly contemptible that its architect has prudently preserved a strict incognito;—the fragment of the Calton Hill Parthenon that was to have been; and the Scott structure, which, sooth to say, is but a very so-soish specimen of Gothic. Probably some of the more recent buildings may show a little advance in architectural taste, but hitherto it has been at a very low ebb indeed, a good deal of the Edinburgh architecture being truly Pecksniffian, although it has the advantage of being all of genuine stone; yet it would, perhaps, be more correct to call that a disadvantage, since the durability of the material serves to perpetuate and record the poverty of design exhibited in the buildings themselves, and their utter want of æsthetic value. Though the picturesque of filth and wretchedness may be found in many of the "wynds" and lanes in the older part of the city, the modern architecture of the Northern Athens is almost the reverse of pictorial,—chillingly cold, tame, and insipid; which accounts for the picturesque just mentioned being selected by draftsmen and illustrators in preference. The stone edifices of Edinburgh reconcile us to the "lath and plaster" ones of London;—as to the matter of the "lath" it happens to be invariably of brickwork, therefore far more substantial than it has the credit of being; and as to "plaster columns," there is no occasion to rail at what exists only in imagination, unless it has been found that either cast-iron or brickwork becomes transformed as to mere plaster, as soon as it is plastered over.—To skip back to Edinburgh, its buildings *sound* much *better* than they *look*, which accounts for the architects themselves not ever publishing designs of them, notwithstanding the admiration they seem to excite, if we may judge by the vapouring made about them. Drawings are in one respect the best test of architectural design, because design is then judged of by its intrinsic merit and the taste displayed in it, apart from adventitious circumstances, and those of material; the excellence of which last, or the contrary, is not to be imputed to the architect himself. In drawings, while stone buildings show no better than if they were of meaner material, the merit of tasteful design in "lath and plaster," may be enjoyed without any drawback, and we have the satisfaction of knowing that if the structures themselves are of perishable quality, their beauty is rescued from destruction and preserved by the graver, as is the case with many antiquities, and also many far distant buildings which we are acquainted with only by means of the representations of them.

III. The Institute is no Society for the Diffusion of Knowledge either useful or useless. What knowledge it gets it keeps to itself; and truly, knowledge is so valuable a commodity that it ought not to be squandered away in lavish largesses to the public. The Institute is perfectly free from the mania of proselyte-making; it has no notion of encouraging architectural "education for the people," but leaves the people, or people who would fain understand something of architecture, to instruct themselves as well as they can, or else—which is perhaps better still—to remain in ignorance. Nor, indeed, is it by any means certain that a more general diffusion of taste for the art would at all increase the amount of admiration now bestowed on some of its productions and their authors, or the amount of satisfaction derived from them to the public. Great truth is there in the maxim of *omne ignotum pro magnifico*, as there is also in the remark that "familiarity is apt to beget contempt;" and there most assuredly would be danger of its being discovered how very little mind, or talent of any sort there is in many things that have been cried up as wonders. Thanks to their convenient ignorance, there are a good many honest people who have no suspicion whatever that the "fine" and "grand" columns they behold, and whose "hard names" are to them a mystery, are only copied from patterns got out of books. It would be cruel to undeceive them,—to dissipate the dreamy wonder that now fascinates them; and cruel not only to them, but also towards those whose works now pass with the ignorant for marvels of art. If the public is to be liberal with its admiration, it must not be *clairvoyant*. On no account should it be suffered to know enough to be able to criticize fairly and justly; so that it can but find words for praise, that is sufficient, and if they are somewhat ill-applied, they are not, on that account, likely to be the less laudatory, or less magnificent in sound. It is, however, exceedingly difficult to hit the exact mark, and to keep the public at that convenient point of the thermometer of taste, where ignorance of art is so free from indifference towards it, as to be accompanied by a praiseworthy relish for it. While it is proper, it would seem, that persons in general should not be at all instructed in architecture, it is desirable that they should take great interest in it, and be disposed to encourage it very liberally. Architects are apt to complain of the obtuseness and obstinacy of employers—of the stupid whims and caprices which have caused many a fair idea to be marred, but they do not perceive that the only real remedy is to be sought in the better instruction of that class of the community to which architects look for their employers.—But I am interrupted—

IV.—A packet has this very instant been put into my hands; I open it, and find a book, I open that too, and turning over its leaves immediately alight upon the following very free remarks upon the Institute:—

"Their policy, I say, is bad, utterly bad; but I do not say blameable: it is *mistaken*. They have, I doubt not, as sincere and honest a desire for the advancement of the art as I could possibly claim; but their policy is a false one, and in manner as well as in matter. The doctrine of the Institute is false; the constitution of the Institute is false likewise. And when I point out (according to my judgment) the errors in general faith, I would point out also (as equally important), the errors in government of our national school of the art. The Royal Institute of British Architects has not a free liberal constitution. It is beneath the level of other institutions of the country. And this ought not to be. Mistaken doctrine is bad, mistaken policy is perhaps worse. The narrownesses, coldnesses, roughnesses, of much of our social system are expanding, warming, softening, in these days. Year by year the thoughts of men are widening. And the broader basis, the kindlier liberality, the freer liberty, have never failed to be productive of good!

"The curse of the Institute is the constitution of its Council,—an irresponsible and despotic secret government, which, in the circumstances, it would be preposterous to expect to rule otherwise than with narrowness, jealousy, and pique, wanting in ingenuousness, weak in disinterestedness. There are cases in which a committee of the noblest and best could not possibly be otherwise than a clique. The Institute is no representative of the Architects of Great Britain at all. And it is but natural: to become so (as it ought to be) it must change;—and first its government; its doctrine will come secondly in due course. Its gross *exclusiveness* generally is a grand error.—It is too professional, another grand error."—Dr. Verd. "Tell us then, friend, what thou wouldst have it to be."—Mr. Newl. "A *broad-based*, *free*, *disinterested* school of architecture;—*open to all* who love the art,—old and young, professional and non-professional *alike*;—a free theatre of *liberal discourse*,—a society of *artists* and *art-lovers* in architecture, for the ends of architecture *purely*; sly *ballot-boxes* and *secret councils* utterly overthrown, as tyrannical, illiberal, and bad. That is what I would have, and what the public of England, and *architects* especially, are entitled to *demand*.—Let the Institute change its character, and repudiate all close-fisted and selfish policy,—all *professionalism*,—and hoist the banner of *art*, free to all, and to all equally."—*The Newleafe Discourses*.

V. A capital fellow that Newleafe! and a capital book!—one likely to do a great deal of good, by clearly explaining the character of architecture as a fine art, as which it is now scarcely recognised at all, except merely nominally and by courtesy; nor have architects themselves much clearer notions of it than those who are not architects. Not only is its doctrine excellent, and perfectly free from all conventionality, and cant, but the book itself is so clever and entertaining, so full of original thinking—of shrewd remark and caustic pleasantry, as when once opened to be found irresistibly fascinating. Even those who dislike the writer's opinions, and more especially their being uttered to the world, accompanied with so many home-truths—and they will not be a few—will be forced to read on in spite of themselves. Speaking as he has done of the Institute, it argues considerable boldness in the writer to put his real name on the title-page; one which till now has never been before the public, but which is likely to be henceforth more and more distinguished, since it is not to be supposed that one who has made his *début* with so much spirit, will now lay down his pen. Some parts of the book are quite dramatic, and the characters of Mr. Scamozzi-Brunelleschi Brick, Dr. Bluebottle Crape, the antiquary, Mr. Cœur-de-Lion Mwffe (*sic*) the ecclesiologist, and little Smug the travelled architect, are admirably hit off characters, with merely the slightest *soupçon* of caricature. What the Vitruvianists, the archæologists, the Camdenists, and the Ecclesiologists will say of the "Newleafe Discourses," is more doubtful than what they will think. Probably they will, as the wiser course, say little or nothing, but that they will think Newleafe a formidable opponent is an assured certainty;—and all the more formidable because he will have the public on his side, and his example may stir up others to continue the assault upon those inveterate—not, it is to be hoped, invincible prejudices which beset architecture on every side. One commendable trait of spirit in the writer is that he shows himself perfectly free from *flunkyism*; he is not awed by the authority of names, pays no servile deference to professional rank, but censures erroneous opinions in "a Professor," with just as little ceremony as he would in any other individual. Both Professor Cockerell and Professor Willis get a few rubs from him; and if they deserve them, why should they not? At any rate they are game worth aiming at, whereas some others are hardly worth powder and shot.

FENESTRATION AND WINDOWS.

THIRD ARTICLE.

In returning to our subject we shall not pursue any farther our remarks on Fenestration in connection with modern church architecture, because we purpose going into the latter subject generally, and inquiring how far it is adviseable entirely to repudiate for buildings of that class, the Greco-Roman style, instead of taking it up again with a fresh and better spirit, so as to infuse into it renewed vitality. We will, however, just advert here to one unseemly defect which deforms most of our churches in that style—if, indeed, they can be said to belong to it, very few of them possessing what can fairly be called style at all. We allude to the practice of making a row of small mezzanine-looking windows beneath the others, to the great injury of character, composition, and breadth, and of unity likewise, for such little windows seem to express a division of the building into distinct floors within, and appear to belong to low ground-floor rooms intended for inferior purposes. At any rate such apparent division of the structure must be considered an indefensible solecism by those who make it an objection against St. Paul's, that its exterior is divided into two orders. In some cases, indeed, the practice in question is harmless enough, there being neither beauty nor pretension to it, nor any kind of architectural quality to be injured by it; but in St. Pancras' church the small lower windows are glaringly and offensively at variance with the scrupulous—perhaps somewhat over-scrupulous adherence to the original classical pattern, which, unluckily, not going far enough for the occasion was eked out with some "ready cut and dried," but not very classical ideas.

From what we have just been saying the transition will not be very abrupt, if we now proceed to consider one very material point in Fenestration with regard to composition. We have already said that *interfenestral* breadth is one great requisite for good fenestration—almost essential for greatness of manner and dignity of character, and have now to observe that there ought to be "breadth" in both directions—vertically as well as horizontally, for if there be not corresponding largeness of spacing between the several tiers of windows or floors of the building, as well as between the windows on each separate floor, the design will so far partake of littleness and be of the ordinary stamp. Quite contrary to vulgar opinion it may safely be laid down as a maxim that dignity of expression in architecture is in inverse ratio to the number of windows or aggregate superficies of opening compared with the general surface of the building or entire elevation. It is not the frequency, but the paucity of windows that conduces to nobleness of physiognomy in architecture; whereas, on the other hand, that quality—the unquestionable aristocratic mark—can hardly be maintained at all where inflexible necessity demands closely-spaced fenestration. No matter what size a building be, without something like greatness of scale,—nobleness of taste of course included,—its greatness will amount to no more than the vulgar quality of mere bigness. And unfortunately—or rather, fortunately, grandeur of scale is what cannot be mimicked or counterfeited. It is not to be produced by clubbing a number of ordinary-sized houses together into one elevation, for the individual littleness leavens the whole mass, and the larger the latter is, all the more strongly does the littleness which it is attempted to disguise, contrast with the more than ordinary pretension that is made so indiscreetly and so awkwardly.

The two houses facing each other at the Albert Gate, Hyde Park, seem to have been expressly intended to make manifest the striking difference of character produced by closely or widely spaced fenestration; for though they are of the same size, and in other respects alike, while that on the East side is only three windows in breadth, the opposite one is of five, and the very superior appearance of the former must, we think, strike every one who has the slightest tincture of architectural taste.* Yet if so far that East house excels as well as differs from the opposite one, in another it resembles it in regard to fenestration, aud perhaps even to greater disadvantage, it becoming in consequence of unequal character, insomuch as it consists of the same number of stories, therefore the *vertical interfenestration*† is not so good as the *horizontal*, owing to there being too many tiers of windows, and they are put too closely together—or in other words, and to express our meaning by a single term, the interfenestration in that direction is *thickset*, or pycno-fenestration; and, as has been already observed by us, although pycno-style columniation produces richness, pycno-fenestration is generally attended by an air of littleness, if not of meanness. Except in Gothic—the Perpendicular and Tudor styles, also Elizabethan, wherein fenestration may without impropriety be carried to any extent, it being, as we have already said, highly characteristic and expressive also of construction,—crowded fenestration produces confusion, and a great deal more than the space properly admits of, seems to be crammed into a front. As an instance of the kind—an example that forcibly illustrates what we have just said, we may point to the group of three tall stone-fronted houses erected a year or two ago in Grosvenor Place: intended to be more than ordinarily dignified, they are so terribly deficient in amplitude of proportions, as to look compressed and crushed horizontally, while loftiness is obtained not by lofty proportions, but merely by piling up an unusual number of stories. Another example of the *ad evitandum* class is the Atlas Insurance Office, Cheapside, and a remarkable one it is for *mesquinerie* and tastelessness both in regard to fenestration and to columniation also. We will not at present touch upon what some are altogether intolerant of, and peremptorily denounce without further consideration as a barbarous solecism—we mean the application of columns and pediments to the windows themselves,—because that is a matter which we shall have to discuss somewhat fully when we reach that part of our subject, but we certainly have nothing to say in favour of that particular specimen, for besides that the columns to the windows crowd up the intercolumns of the order, in which they are set, too much, the display affected by means of them is so far from being consistently kept up that their entablatures are even more bare than those usually employed for windows, there being instead of architrave and frieze, or moulded architrave only, a mere black surface between the capitals of the columns and the cornice, notwithstanding that the capitals themselves are Corinthian. The division of the building into two distinct orders,—one for each floor above the basement; cuts it up very disadvantageously, causing it to appear upon a contracted scale, whereas had the composition been astylar, it might have possessed a greater degree of ornateness as well as simplicity, for at present the details are very crude and common-place.

We now proceed to consider what is a very important matter in fenestration, whether with or without columniation, namely, the number of windows from the ground upwards, or of tiers of them, that can with good effect be introduced in architectural composition. And here again we find that it is paucity, not number, which contributes to nobleness of manner. A front may be prolonged horizontally to any extent, without the fenestration itself being thereby in the slightest degree affected, but it cannot be extended upwards *ad libitum*, by adding story to story. On the contrary, the maximum is very limited, if good composition is to be observed, it being scarcely possible by any sort of management to introduce more than three rows of windows—that is, two besides the ground-floor—into a well-proportioned elevation. The greater the number of stories, the smaller do the windows become in proportion to the general mass; and though if looked at as a mere pile of building, the structure may be striking enough by its unusual height, and perhaps possess even some degree of grandeur when it comes into view as a distant object, it will be any thing but dignified in regard to architectural physiognomy; and littleness of manner will be aggravated in the same ratio as the number of stories is increased. Therefore whatever pretension be affected for them by means of decoration, many-storied houses—even when combined with others so as to form a general elevation, well proportioned as to relative height and breadth,—are the reverse of aristocratic in appearance, inasmuch as they look more like barracks than palaces—or if not exactly like barracks, like large hotels and lodging houses—buildings erected for the accommodation of a number of families upon a limited ground-site.

If orders are employed—and in combination with windows, pseudo-columniation (or attached columns) is preferable to the genuine—considerable difficulties are apt to arise, both as regards fenestration and the order

* Since it was first erected, however, the front of that house has been most barbarously disfigured by one of the ground-floor windows being enlarged, without the slightest regard to appearance in any one respect. The house seems to have fallen into the hands of some tavern-keeper.

† We make no apology for coining and employing what some will object to as "new-fangled" words: they are sufficiently intelligible and expressive, and being expressive are useful. Well grounded objection there may be to the merely disturbing the terminology of the art by the revival of obsolete terms in lieu of those in general use, or by substituting for the latter, others which if more correct are only equivalent to them; but it is surely rather desirable than the contrary that the deficiencies in our present architectural vocabulary should be filled up, which can be done in no other manner than by inventing sufficiently significant terms for the respective occasions; and of course when they first come up they are liable to be called "new-fangled":—what then?—to stand in awe of the reproach of "new-fangled" is downright "Old Ladyism." The Germans, we find, have begun to adopt from us—at least adopt into their Art-lexicons, the terms Diprostyle, Triprostyle, &c.; yet we have heard them, if not positively objected to, attempted to be depreciated, because—O what an excellent and sagacious "Because"!—because any one acquainted with the Greek numerals might have formed them—and we suppose also becaus tehey are so exceedingly simple, clear, and intelligible, when once explained, that a child may understand them.

itself. Good composition does not admit at the utmost of above two tiers of windows in the intercolumns, and even then it is better if the second range of them are either mezzanine ones, or very little more in height. Therefore, if two stories are required above the ground-floor, the latter must be treated as basement, and the order be elevated upon it,—the course which Barry was forced to adopt in altering the Board of Trade. That done, an additional range of windows can be obtained only in the form of an attic story, because to put a second order over one which comprises more than a single floor, and therefore ought, exclusive of other superstructure than a mere attic, to complete the elevation, is beginning again, and piling up one building on the top of another. Either there ought to be a separate order to every separate floor—no matter how many, —or if the composition be not regulated that way, there ought to be no more lines of windows than will properly come in within a single order. As far, indeed, as precedent to the contrary avails anything, it may easily be found, as it may for a great many other faults of composition, and we have now got precedent for *poly-fenestration*—so to describe it—in conjunction with an order, where three tiers are inserted into the intercolumns, such being the design of the front of the Royal Institution in Albemarle-street, and the wings of the British Museum. In one respect, perhaps, such disposition seems to suit colmumniation exceedingly well, because the intercolumns are kept narrower; yet that single advantage is considerably outweighed by several inconveniences. While, on the one hand, fenestration preponderates too much in the general composition, owing to the multiplicity of windows; so, on the other, does columniation (columns or pilasters, as may be the case,) make the windows appear comparatively insignificant features; nor is it the columns alone that do so, for they being nearly as much in diameter as the width of the windows, the entablature, proportioned to them, seems quite disproportioned to the height of the floors. The consequence is, the order and the building itself are upon different scales; the former has the look of having been originally intended to form an open colonnade, whose intercolumns have been afterwards built up and filled in with windows, as was actually the case with the Temple of Antoninus, at Rome, which Bernini (if we mistake not) converted by such process into the Dogana or Custom-house. Thus the temple and house-front characters, irreconcileable and repugnant to each other as they are, are brought into immediate contact with each other. The Albemarle-street building is evidently *after* the Roman one, and the Museum wings are not much *behind:* all that is not column is window, and *vice-versâ*. If, however, such mode has nothing to recommend it æsthetically, it has the merit of being an exceedingly simple one, and of evading a great deal of trouble.

RUSTIC MASONRY.

We have been compelled by the more immediate urgency of other subjects to defer till now the reply to the paper on Rustication, by Candidus, which appeared in our August number. Free discussion respecting the principles of architecture is by no means to be discouraged, for during the last three centuries mere conventionalism has so completely usurped the place of true art, that we may easily foresee the long and obstinate contest which prejudice will wage against the resumption of correct principles. Still, the discussion, however necessary it is for ultimate success, must be restrained within certain limits; and we therefore feel entitled to protest against the controversial tone assumed by our opponent. The paper to which we are about to reply, commences with the assumption that our profession of willingness "to be set right," was insincere; and though there has been no hesitation in bringing this charge of disingenuousness, not the least attempt is made to support it. Bare assertion can only be met by counter-assertion, and it therefore seems sufficient to assure Candidus that our declaration of readiness to listen to temperate reasoning was made in perfectly good faith, and that we see no reason to repent of having made it.

These preliminary remarks seem the more necessary because the chief object of the present paper will be not so much to defend our original arguments, as to show that the purport of them has been generally misunderstood in the subsequent paper. Passing over, therefore, the first paragraph, in which the writer states, with singular modesty, his intention of exposing the "futility and one-sidedness" of our objections, we come to the first argument properly so called:—it is, that as this country possesses neither the marble nor the climate of Greece, our masonry will not retain perfect uniformity of tint and surface, and that it is an advantage to obtain a different species of regularity by the means of rustication. This, like most apologetic argument, proves too much; for the direct conclusion from it is that rustication should be employed in this country—not occasionally—but always. The rule would stand thus that in Greece and all "sunny climes" rustication should *never* be adopted, but that in all northern or humid countries, the joints of masonry ought on *all* occasions to be bevilled in order to palliate the effect of diversity of "tint and surface." In this case then, unfluted columns, such as those of the portico of the Royal Exchange, should be marked by a series of horizontal annuli at the junction of the blocks composing each shaft. The same argument would apply to Mediæval architecture also, and we must conclude that the walls of our cathedrals would be improved in appearance if covered with a rectangular mesh-work of horizontal and vertical lines.

The next paragraph attributes to us a condemnation of all that has been added to or engrafted upon Grecian architecture—a condemnation of Roman and Italian architecture. This statement is inaccurate—we would indeed reject the combination of the principles of Greek architecture with other discordant principles, and readily avow that many (not all) of the innovations of the Roman and Italian styles were inharmonious. This however does not amount to a total condemnation of those styles, and we have elsewhere attempted to point out in the paper on "Trabeation and Arcuation," the true method of discrimination. We may here notice, out of its course, an assertion in another part of the paper now under discussion, in which we are accused of "fairly damning modern architecture altogether." The charge is as unfair as it is unfounded; if the object of it be to enlist the prejudices of the reader against our arguments, it signally fails of its effect, for we have never condemned any modern building in which the canon of architectural faithfulness is tolerably well observed. We have frequently spoken of the superiority of modern architecture to that of the last age, and have occasionally done even some violence to our opinions, by speaking in terms of partial admiration of buildings which exhibit little regard for principles of constructive decoration.

The objection that our views respecting rustic masonry ought for consistency to be extended to the fluting of columns seems purely factious, since it is obvious that parallel lines of fluting contribute to the principal æsthetic idea of columns—their verticality; whereas our main argument against scoring masonry all over with a vast number of lines running both perpendicularly and horizontally was that they distracted the eye and suggested no æsthetic idea whatever. The remarks respecting the Madeleine, must have been written in total misapprehension of our meaning, or else are the result of a hasty and careless inspection of that building—if indeed there be not an attempt on the part of the writer to criticise the architecture without having *seen* it. We will venture to say that no competent observer, who has actually inspected the Madeleine, will contradict our assertion that the horizontal channels indented in the walls of the cella greatly injure the effect of the periptery. The columns do not stand out with that bold relief, which they would have, were the background left plain, and their vertical character is greatly injured by the horizontal lines running behind them and apparently meeting them at right angles. This is so notoriously a matter of fact—of common observation, that it has never yet been disputed by those who have seen the building. However, we may perhaps facilitate the proper conception of the argument by referring to analogous instances nearer home. If Candidus will examine the two last plates in this Journal, representing the Board of Trade as it was, and as it is, he will find in both façades a number of horizontal lines extending the whole length of them, which distract the eye and almost destroy the vertical character of the columns. In the later edition of the Government offices the rustic lines are not continued quite up to the columns, but stop against a plain panel; still the defect is but little palliated by this contrivance—the mental eye continues the lines, and the natural eye is consequently offended by the incongruity and confusion. The same remark applies to the windows between the columns: the mouldings of the sills and architraves range in horizontal lines, and the effect is nearly the same as if those lines were continued to meet the columns. This seems the true reason for the axiom laid down by many architectural writers that two ranges or stories of windows ought not to be included within one order of columns, and also for the objection laid down in the article on Fenestration (p. 271), that where windows are introduced between a colonnade "the columns seem as much to encumber as to adorn the front behind them, certainly not to belong to it by growing out of the general organization." The horizontal lines of the sills and architraves are mentally united by the observer, and have the effect of being continuous: the eye recognizes the windows, not separately, but collectively as one range; and the general direction of this range being horizontal, and therefore at right angles to the columns produces inevitably the appearance of disconnection among the component members of the architecture.

The paragraph in which the rusticated masonry of the Madeleine is defended, concludes by attributing to us certain opinions on Grecian architecture which the writer justly treats as absurd. As, however, we never expressed these opinions, we are not called upon to defend them.

Of the Architecture of Newgate it is observed, "had it not been rusticated, it would have been comparatively an insipid blank." Why, yes; this is true enough, and it brings us precisely to the very gist of the argument. Our real ground of objection to rustic masonry is not so much that it is intolerably ugly in itself as that it stands in the way of something better—bold and effective composition. Had the architect of Newgate been debarred from the paltry expedient by which he has palliated the nakedness of his design he must have contented himself with this alternative—either to let the poverty of his ideas manifest itself undisguised, or else to substitute a design possessing intrinsic and legitimate merit.

On examination we shall find the same remark applicable to the general employment of rustic masonry. Where the architect possesses real genius and correct principles of taste, the beauty of his architecture will be attained by massive combinations, by effective distribution of light and shadow, by graceful proportions, by strong contrast between the decorated and undecorated parts, and by making the mechanical construction of the building a source of beauty. In proportion as his conceptions are vigorous and effective, he will have the less necessity to resort to rustication and other insipid inexpressive save-trouble expedients. We would deprive architecture of these expedients for the same reason that we would deprive a child of its go-cart—that it may learn to run alone. When these tricks of art are got rid of, good architects will be *forced*, as it were, to trust in their own strength, and bad architects will do as they always have done—follow their betters.

If our opponent could have assigned only one good reason why rustication should be employed in Classic and not in Pointed architecture, we should have been satisfied that he argued on abstract principles, and that his judgment had not been (as we sincerely believe it to have been) perverted by custom. This opinion is not uttered invidiously, for we know how hard it is for those who have been long habituated to technical rules, to look beyond them. It is well enough to tell us that "separate styles have, like separate languages, their respective idioms and peculiarities;" and that Rustication may be considered as a characteristic peculiarity of one kind of Classic architecture—"as being part of its costume, consequently proper to that, though in any other it might show as a decided impropriety." But why—for what reason an impropriety in any other style? The only possible answer to this question is to show that the style with which alone rustication harmonizes, possesses certain distinctive principles which produce this harmony, but which exist in no other style. If there be such principles in Classic architecture, it is surely very easy to point them out. We all know what are the main distinctions between Classic and Pointed architecture: the one is horizontal—the other vertical; the one simple—the other complex; the one rectilineal—the other curvilineal. To which of these or the other distinctions between the two great architectural systems are we to attribute the circumstance that rustication accords with the one, and not with the other? This will, we think, be found on reflection an indisputable position—that either rustication offends against those Catholic principles which apply to all styles alike—or else that Classic architecture has certain principles, possessed by no other style, which render rustication applicable to it alone.

Which member of this alternative is to be adopted? If the first, there is an end of the controversy. If the second, our opponents have still to point out the existence of the principles by which their position is defended. Therefore the whole question may in some sort be said to turn on the causes of the incongruity of rustication with Pointed architecture. Now, as far as we can see, it would be less incongruous with Pointed than with Classic architecture, for the former delights in a multiplicity of lines which is directly antagonistic to the latter.

Our objection that rustication precludes a contrast between the ornamental and plain parts of the structure has not yet been answered. To our view, decorations derive their chief grace and fitness from *contrast*. If *every* part of a building were richly ornamented it cannot be denied that a dazzling and gorgeous effect might be produced. But the most *artistic* architecture is not that which is most ornamented, but that in which the decorations and plain surfaces are balanced against each other—in which some parts are purposely left undecorated in order to enhance the beauty of the rest.

The connection between the subject in dispute and that of mouldings seems also to have been misunderstood. The æsthetic value of mouldings seems to consist in this, that they mark distinctly the mechanical construction of a building. In Classic architecture the cymatium, &c., mark the outline of pediments; the antepagmenta of doorways, the tænia indicates the super-position of the cross—joists on the architrave and the mutule marks the termination of the inclined rafters of the roof: in Pointed architecture the hood mouldings defines the arch of the windows, the corbel table indicates the manner in which a roof or upper floor is supported: in Italian architecture also the division of a building into stories is frequently with the utmost propriety exhibited externally by horizontal mouldings. But without the mouldings have thus a logical fitness, they are adscititious and indefensible. It is clear moreover that their value as indications of construction must be nearly annihilated where the *whole* surface of the walls is marked with lines like those of rustic masonry. In such cases they cease to be *distinctive*.

Another misapprehension of our meaning respecting rustication is the supposition that we have insisted "that it is absolutely intolerable." This is not the case: on the contrary, we think there are many buildings which as they stand are improved by it, or rather would be worse without it. It is not rustication, so much as the necessity for it, which we wish to get rid of. There are many buildings—the Reform Club for instance—of which the architecture is intrinsically too good to need such embellishments.

The true end of art is to produce the greatest effect with simple means. It is easy enough to overload a building with mouldings and sculpture—to do that requires not genius but money; and the vulgar, caught by the glare, will give to the architect the credit which is in fact due to the workman. Architecture, except during its purest periods, has always tended to degenerate into a system of surface-decorations. It is so now, and ornament usurps the place of architecture. Directly the system of polychrome decoration was revived how eagerly was it caught at! It is such an easy method of making a building look showy! Fresco-painting also, encaustic tiles, and cheap imitations of costly woods will often save the architect a world of trouble—the trouble of thinking. And yet these things are not intrinsically worthless, or to be despised; unlike Rustication, they are valuable accessories of art, but no more than accessories—excellent servants, but bad masters.

THE NEW PLANET.

The discovery of a planet of which the existence, distance, orbit, and mass had been *predicted* by mathematical computation long before its presence in the heavens had been recognised by the telescope, may justly be considered, as Mr. Hind observes, "one of the greatest triumphs of theoretical astronomy." It cannot but be a matter of regret to find the new planet called Le Verrier's, whereas in fact the first theoretical discovery of it is due to Mr. Adams, who to our certain knowledge completed his investigation, as far as the approximations of the first order, two years ago. Sir John Herschel has addressed the following letter on the subject to the *Athenæum*.

Collingwood, Oct. 1.

"In my address to the British Association assembled at Southampton, on the occasion of my resigning the chair to Sir R. Murchison, I stated, among the remarkable astronomical events of the last twelvemonth, that it had added a new planet to our list,—adding, "it has done more,—it has given us the probable prospect of the discovery of another. We see it as Columbus saw America from the shores of Spain. Its movements have been felt, trembling along the far-reaching line of our analysis, with a certainty hardly inferior to that of ocular demonstration."—These expressions are not reported in any of the papers which profess to give an account of the proceedings, but I appeal to all present whether they were not used.

"Give me leave to state my reasons for this confidence; and, in so doing, to call attention to some facts which deserve to be put on record in the history of this noble discovery. On the 12th of July, 1842, the late illustrious astronomer, Bessel, honoured me with a visit at my present residence. On the evening of that day, conversing on the great work of the planetary reductions undertaken by the Astronomer-Royal—then in progress, and since published,*—M. Bessel remarked that the motions of Uranus, as he had

* The expense of this magnificent work was defrayed by Government grants, obtained at the instance of the British Association, in 1833.

satisfied himself by careful examination of the recorded observations, could not be accounted for by the perturbations of the known planets; and that the deviations far exceeded any possible limits of error of observation. In reply to the question, Whether the deviations in question might not be due to the action of an unknown planet?—he stated that he considered it highly probable that such was the case,—being systematic, and such as might be produced by an exterior planet. I then inquired whether he had attempted, from the indications afforded by these perturbations, to discover the position of the unknown body,—in order that 'a hue and cry' might be raised for it. From his reply, the words of which I do not call to mind, I collected that he had not then gone into that inquiry; but proposed to do so, having now completed certain works which had occupied too much of his time. And, accordingly, in a letter which I received from him after his return to Königsberg, dated November 14, 1842, he says,—'In reference to our conversation at Collingwood, I *announce* to you (*melde* ich Ihnen) that Uranus is not forgotten.' Doubtless, therefore, among his papers will be found some researches on the subject.

The remarkable calculations of M. Le Verrier—which have pointed out, as now appears, nearly the true situation of the new planet, by resolving the inverse problem of the perturbations—if uncorroborated by repetition of the numerical calculations by another hand, or by independent investigation from another quarter, would hardly justify so strong an assurance as that conveyed by my expressions above alluded to. But it was known to me, at that time (I will take the liberty to cite the Astronomer-Royal as my authority), that a similar investigation had been independently entered into, and a conclusion as to the situation of the new planet very nearly coincident with M. Le Verrier's arrived at (in entire ignorance of his conclusions), by a young Cambridge mathematician, Mr. Adams;—who will, I hope, pardon this mention of his name (the matter being one of great historical moment),—and who will, doubtless, in his own good time and manner, place his calculations before the public.

J. F. W. Herschel.

Sir John Herschel compares the discovery of the new planet to the discovery of the Western World: he might have added that America did not take its name from Columbus, but from a later navigator.

Professor Challis, of the Cambridge Observatory, has published a statement in the *Cambridge Chronicle*, that, in September and October, 1845, Mr. Adams deposited in the two principal observatories of England, those of Greenwich and Cambridge, calculations of the heliocentric longitude, mass, longitude of perihelion, and eccentricity of the orbit, of the supposed planet. M. Le Verrier published a calculation of the heliocentric longitude of the planet last June (eight months later).

To the personal friends of Mr. Adams the dispute must appear a ridiculous one: seeing that his discoveries have been a subject of common conversation among them for the last two years. And they very well know that modesty, which characterises profound science, alone prevented Mr. Adams from making his investigations known in a more public manner than by depositing them in the observatories of Greenwich and Cambridge. His original intention was, we believe, not to take any active steps for the publication of his investigations till the planet had been observed by the telescope.

The question seems likely to be made the subject of as "pretty" a quarrel as any in which the *savans* have ever been engaged. At a recent meeting of the Paris Academy, the announcement that the English astronomers meant to claim for their countryman the honour of first predicting the place, &c., of the new planet was received with manifestations of the utmost indignation. It is stated that in the excess of their wrath, they did not refrain from designating Airey and Herschell—impostors! In a letter in the *National*, which a correspondent of the *Literary Gazette* attributes to Arago, Sir J. Herschell and Professors Airey and Challis are said to have entered into a conspiracy to rob M. Le Verrier of his discovery. Herschell in particular is reviled with ingratitude because he is the son of one *whose fame M. Arago made known to Europe*." This exceeds the usual limits of even French bombast.

Our own journals take up the question very coldly. Surely this cannot arise from ignorance of the importance of the subject. However, "the truth is great, and will prevail," and as we happen to know personally that Mr. Adams's claims are indisputable, we do not for an instant doubt that they will soon be established to the perfect satisfaction of the public.

The planet is said to have a ring and a satellite: its distance from the sun is three thousand two hundred millions of miles—upwards of thirty times that of the earth. The distance of Uranus from the newly discovered source of its perturbations is one hundred and fifty millions of miles. The new planet is the largest in our system, except Jupiter and Saturn: its cubic bulk being 250 times that of the earth.

The *Athenæum*, speaking of M. Le Verrier, says incidentally, that "he worked out the problem first"! A more heedless admission was never made in a scientific journal: if it be, as it appears to be, a mere *obiter dictum*, the result of sheer carelessness, it ought, for truth's sake, to be withdrawn immediately. We repeat emphatically, that it is notorious to ourselves and to all Mr. Adams's scientific friends, that his discoveries were made long before M. Le Verrier's name was heard of in connection with the subject.

INSTRUMENT FOR TRACING RAILWAY CURVES.

Sir—The accompanying sketch and description of an instrument which I have found extremely useful for setting out railway curves is well adapted for all situations, and is very portable and simple.

A B C′ (fig. 1) is a permanent frame or square B C′ being perpendicular to A B, and B C is a moveable limb with a vernier to read off the degrees on the quadrant. Instead of making the offsets as heretofore perpendicular to the tangents, they are made by this instrument in the direction of the secants as *b c*, *d f*, and *h g*, &c. (fig. 2.)

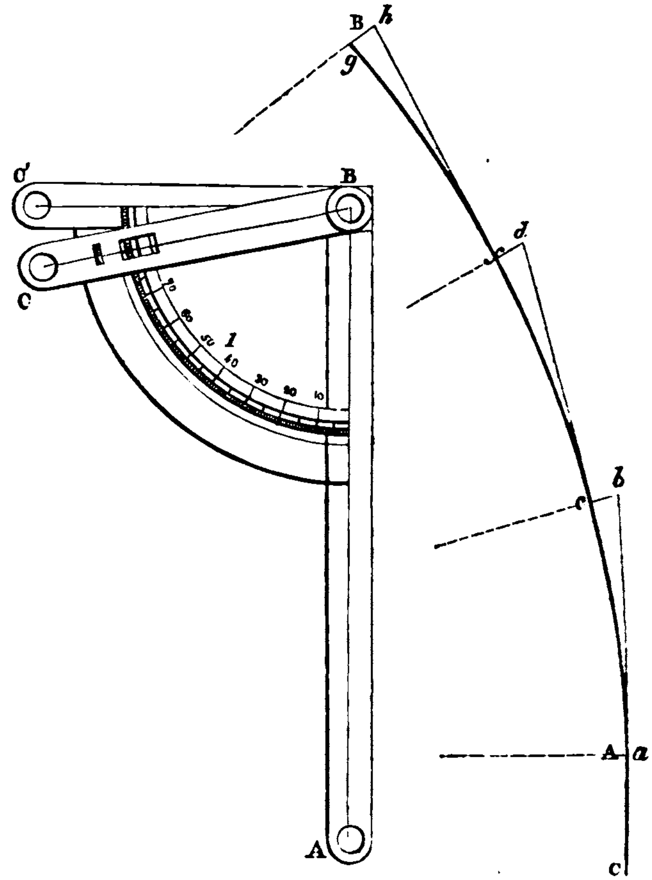


Fig. 1. Fig. 2.

In order to use this instrument, it is necessary to calculate by trigonometry the angle *a b c* fig. 2, and the length of the secant, for the purpose of finding the length of the effect *a b*, the latter is equal to the difference of the radius of the curve and the secant; in all cases it is requisite first to determine what length of tangent is most suitable to the ground, on which the curve is to be set out.

After this the moveable limb B C, is fixed on the quadrant at the angle so found for *a b c*, and the tangent *a b* being traced and measured on the ground, the instrument is placed with B of fig. 1, corresponding to *b* of fig. 2, and B A in the direction of *b a*, being so placed the moveable limb B C, fig. 1, will be in the direction of the required offset *b c*, fig. 2, which is to be measured off accordingly, giving the point *c* (fig. 2) as the first point in the curve A B.

For the second and other points *d f*, and *h g*, and *a*, the instrument is reversed, laying the fixed limb B C′, fig. 1, on the offset *b c*. B of the instrument corresponding with *c*, fig. 2, the line A B of the instrument being perpendicular to *b c*, will consequently point on the ground in the direction of the second tangent *c d*, and at *d* the second operation is to be performed as at *b*, for the offset *d f*, and so on.

The circular openings at A B C′, and *c*, are for the purpose of receiving nicely fitted rods to keep the instrument in its proper positions on the ground until the necessary prolongations *a b*, and *b c*, and *a* have been made.

Wm. Tait.

Military Library, 30, *Charing Cross.*

EARTHWORK ON SIDE-LONG GROUND.

By John Hughes, C.E., A.I.C.E.

The corrections to quantity arising from an inclination of the ground surface, in cross sections, are most frequently neglected, when estimating the cuttings and embankments of a railway or canal. This omission is in general expressly mentioned in the engineer's specification, so as to avoid all question upon the terms of the contract; it gives rise, therefore, to no positive injustice to any party, whilst a statement of the number of cubic yards to be removed, as ascertained from the heights taken along the centre line, is considered sufficiently near the truth to enable a contractor to appreciate the means he is required to supply. This practice obtains, because the corrections for excess and defect are assumed as balancing each other, and because the process of calculating them has been considered a tedious and troublesome labour. My purpose is to show that neither of these grounds should be acted upon;—the first is mathematically unsound, and the strength of the second may be materially abated.

If the ground surface is supposed to be generated by the motion of a straight line, which is always at right angles with the centre line, its ends resting on the outer edges of the slopes, the direction of such motion being coincident with the centre line, and all positions of the generatrix being parallel, then the correction to the area of a cross section of any cutting or embankment first computed on the assumption that this line is horizontal, and that the height or depth is measured on the centre, will, when it has any inclination with the horizontal, always be *additive*. The corrections to widths due to this inclination I will designate by $+x$ on one side, and by $-x'$ on the other; the correction to area will then be represented by the expression $\frac{xx'}{r}$; r being the ratio of the slopes.

If the ground surface is supposed to be generated by the motion of *two* lines, situated in the same vertical plane, having their ends resting on the centre line and on the outer edges of the slopes, all other circumstances being the same as already described, then the correction to area will be on one side, as an addition, supposing the ground to rise $(B+rC)\frac{x}{2r}$; and on the other side, as a deduction, supposing the ground to fall $(B+rC)\frac{x'}{2r}$. Consequently, the whole correction to the area of the cross section, calculated to the height C, in the ordinary way, is $\frac{B+rC}{2r}(x-x')$.

I take leave, at this point, to refer to the diagrams and characters employed in a paper on "Setting out Railways," in the Journal for September last (p. 277), as explanatory of these I now adopt. Moreover, let $+z$ and $-z$ represent the corrections to widths in a cross section parallel to the first at a distance from it $=$ L.

Then, in the case first named, where the cross sections all exhibit the ground surface as a right line, the solid, which is *constantly* to be *added*, has for its value

$$\frac{L}{6r}\left[x(2x'+z')+z(2z'+x')\right]\ldots\ldots\ldots\ldots\ldots\ldots\ldots A$$

And in the second case

$$\frac{L}{6}\left(\frac{B+rC}{r}\right)\overline{(x-x')+\tfrac{1}{2}(z-z')}+\frac{L}{6}\left(\frac{B+rC'}{r}\right)\overline{(z-z')+\tfrac{1}{2}(x-x')}\ldots\ldots B.$$

However complicated these formulæ may appear as algebraic expressions, their numerical application is perfectly simple and easy. To compare the two, let us first consider the increment to the area of one cross section only, which is $\frac{xx'}{r}$, and also $\left(\frac{B+rC}{2r}\right)(x-x')$; by assigning the following values:—

$$B+rC=31;\ r=2;\ x=5;\ x'=3\cdot78.$$

Then, $\frac{xx'}{r}=\frac{5\times 3\cdot78}{2}=9\cdot45$ .... Square feet;

and, $\frac{B+rC}{2r}(x-x')=\frac{31\times 1\cdot22}{2\times 2}=9\cdot45$ .... Square feet.

Also, in the other cross section,

if $B+rC'=35,\ r=2,\ z=7\cdot241,\ z'=5\cdot122$,

we have, $\frac{zz'}{r}=\frac{7\cdot241\times 5\cdot122}{2}=18\cdot54$ .... Square feet;

and, $\frac{B+rC}{2r}(z-z')=\frac{35}{4}\times 2\cdot119=18\cdot54$ .... Square feet.

Upon the choice between these two formulæ, it is proper to remark that although the process according to $\frac{xx'}{r}$ is the shortest, perfect accuracy requires that the values of x and x' should be nicely calculated, even to a third place of decimals, to ensure exact coincidence with the result by the formula $\frac{B+rC}{2r}(x-x')$; and more especially when $\frac{B+rC}{2r}$ is large.

In the next place, let us compare the facilities of the two formulæ for the increment to the solid due to the side-long inclination of the ground with the values above given, the cross sections being 50 feet asunder $=$ L.

First,	$x'=3\cdot78$		$5\cdot122$
	$x=3\cdot78$		$5\cdot122$
	$z'=5\cdot122$		$3\cdot780$
$(2x'+z')=$	$12\cdot682$	$(2z'+x')$ ...	$14\cdot024$
Multiplied by	5		$7\cdot241$
	$63\cdot41$		$101\cdot548$
			$63\cdot41$
			$2)164\cdot958=82\cdot5.$

With this number enter Table No. 1 of my Tables* for calculating earthwork, where I find, on the first line of figures,

opposite 82.	1·0123
" ·5	·0062
For 82·5	1·0185

and multiplying this by $\frac{50}{2}=\frac{100}{4}$ we get ... 25·46 cubic yards.

By the second formula for the increment to the solid, the process will be—

$x-x'$ .... $5-3\cdot78=1\cdot22$ .... this $\div 2=$ .... $0\cdot61$

$\frac{1}{2}(z-z')$ .... $\frac{7\cdot241-5\cdot122}{2}=1\cdot059$ .... this $\times 2=$ .... $2\cdot119$

$(x-x')+\frac{1}{2}(z-z')$	$2\cdot279$	$(z-z')+\frac{1}{2}(x-x)$	$2\cdot729$
$\frac{B+rC}{r}=\frac{31}{2}=$	$15\frac{1}{2}$	$\frac{B+rC'}{2}=\frac{35}{2}$	$17\frac{1}{2}$
	$35\cdot324$		$46\cdot393$
			$1\cdot364$
			$47\cdot757$
			$35\cdot324$
	$1\cdot0247$	.... from Table No. 1	$83\cdot081$
	$\cdot0009$		
	$1\cdot0256$		

and multiplying by $\frac{50}{2}$ .... 25·64 cubic yards.

A slight examination will enable us to perceive that the last is the preferable process to be adopted in practice; for as an algebraic expression it involves less trouble, although apparently the contrary; and avoiding the extreme nicety necessary in the values of x, x', z, and z' in the first is, even in the hypothesis of the generatrix of the ground surface being one straight line, the most accurate of the two.

This hypothesis will never be satisfied over the most uniform ground, and in this sense also the second formula claims the superiority. Expressed in words, it may be stated as follows:—

1. Take the difference between the additive and subtractive corrections to the widths at each cross section terminating the length of cutting or of embankment under calculation.

2. Add together half the width of the railway previously divided by the ratio of the slopes to the height at the centre of each cross section; and call these the multipliers.

3. To the difference of the corrections to widths in each cross section add half the difference of the corrections in the adjoining cross section, and multiply these sums by their respective multipliers.

4. The last two results added together and multiplied by one-sixth of the distance between the cross sections gives the solid content sought.

The rule thus expressed requires modification according to the signs attaching to x, x', z, z', as will be evident to every one familiar with the first principles of algebra, and needs no further remark here.

* "Concise Tables to facilitate the Calculation of Earthwork and Land required in the Construction of Railways, Canals, and other Public Works; adapted to the Practice of the Engineer, Architect, and Surveyor." By John Hughes, engineer. London: Effingham Wilson, Royal Exchange.

The elements for calculating the corrections to cubic quantity which have been previously employed, require that the corrections to widths, due to the inclination of the ground surface, should be determined; that is, that the values of x, x', z, and z', should be known; and this process may appear to involve as much trouble when preparing a preliminary estimate for ordinary parliamentary purposes, as when the position of the line is absolutely final: and when the more careful and accurate calculations are undertaken. They would appear, in fact, to require that the field-work should embrace every level and measurement necessary for setting out the earthwork on the ground. It is desirable, therefore, to present a form of calculation which should dispense with so much detail, and which should at the same time enable us to make an estimate that cannot be attacked before a committee of the House of Commons for insufficiency, on the score of a neglect to take into account the addition to be made to quantities derived from the central heights, on the supposition that the ground in cross section does not differ materially from a horizontal plane; an addition which is due to the fact that this supposition cannot be maintained in a mountainous or rough country, such as occurred on the various lines projected through Wales in the session of 1845-6.

Under such circumstances, after the usual deposit of the plans and sections have been made, in accordance with the standing orders, it should be included amongst the various additional particulars sought by the engineer preparatory to his estimate, to obtain a number of cross sections, over the length of each projected cutting or embankment, sufficient for determining the increase in earthwork which may arise from a material inclination of the ground to the horizon. And, *now*, the first formula (A) is, on the whole, the most concise in application. Such cross sections can do no more than exhibit the *rate* at which the ground inclines; in other words, to what extent it falls or rises in any given horizontal distance, as of 100 feet, or 1000 feet, &c.

Table for Corrections to Widths of Railways, &c., due to Sidelong Ground.

	0	1	2	3	4	5	6	7	8	9
0		1·0000	·5000	·3333	·2500	·2000	·1667	·1429	·1250	·1111
10	·1000	·09091	8333	7692	7143	6667	6250	5882	5556	5263
20	·05000	4762	4545	4348	4167	4000	3846	3704	3571	3448
30	·03333	3226	3125	3030	2941	2857	2778	2703	2632	2564
40	2500	2439	2381	2326	2273	2222	2174	2128	2083	2041
50	2000	1961	1923	1887	1852	1818	1786	1754	1724	1695
60	·01667	1639	1613	1587	1563	1538	1515	1493	1471	1449
70	1429	1408	1389	1370	1351	1333	1316	1299	1282	1266
80	1250	1235	1220	1205	1190	1176	1163	1149	1136	1124
90	1111	1099	1087	1075	1064	1053	1042	1031	1020	1010
100	·01000	·009901	9804	9709	9615	9524	9434	9346	9259	9174
10	·009091	9009	8929	8850	8772	8696	8621	8547	8475	8403
20	8333	8264	8197	8130	8065	8000	7937	7874	7813	7752
30	·007692	7634	7576	7519	7463	7407	7353	7299	7246	7194
40	7143	7092	7042	6993	6944	6897	6849	6803	6757	6711
50	6667	6623	6579	6536	6494	6452	6410	6369	6329	6289
60	·006250	6211	6173	6135	6098	6061	6024	5988	5952	5917
70	5882	5848	5814	5780	5747	5714	5682	5650	5618	5587
80	5556	5525	5495	5464	5435	5405	5376	5348	5319	5291
90	5263	5236	5208	5181	5155	5128	5102	5076	5051	5025
200	·005000	4975	4950	4926	4902	4878	4854	4831	4808	4785
10	4762	4739	4717	4695	4673	4651	4630	4608	4587	4566
20	4545	4525	4505	4484	4464	4444	4425	4405	4386	4367
30	·004348	4329	4310	4292	4274	4255	4237	4219	4202	4184
40	4167	4149	4132	4115	4098	4082	4065	4049	4032	4016
50	4000	3984	3968	3953	3937	3922	3906	3891	3876	3861
60	·003846	3831	3817	3802	3788	3774	3759	3745	3731	3717
70	3704	3690	3676	3663	3650	3636	3623	3610	3597	3584
80	3571	3559	3546	3534	3521	3509	3497	3484	3472	3460
90	3448	3436	3425	3418	3401	3390	3378	3367	3356	3344
300	·003333	3322	3311	3300	3289	3279	3268	3257	3247	3236
10	3226	3215	3205	3195	3185	3175	3165	3155	3145	3135
20	3125	3115	3106	3096	3086	3077	3067	3058	3049	3040
30	·003030	3021	3012	3003	2994	2985	2976	2967	2959	2955
40	2941	2933	2924	2915	2907	2899	2890	2882	2874	2866
50	·002857	2849	2841	2833	2825	2817	2809	2801	2793	2780
60	·002778	2770	2762	2755	2747	2740	2732	2725	2717	2710
70	2703	2695	2688	2681	2674	2667	2660	2653	2646	2639
80	2632	2625	2619	2611	2604	2597	2591	2584	2577	2571
90	2564	2558	2551	2545	2538	2532	2525	2519	2513	2506

Table for Corrections to Widths of Railways, &c.—(Continued.)

	0	1	2	3	4	5	6	7	8	9
400	·002500	2494	2488	2481	2475	2469	2463	2457	2451	2445
10	2439	2433	2427	2421	2415	2410	2404	2398	2392	2387
20	2381	2375	2370	2364	2358	2353	2347	2342	2336	2331
30	·002326	2320	2315	2309	2304	2299	2294	2288	2283	2278
40	2273	2268	2262	2257	2252	2247	2242	2237	2232	2227
50	2222	2217	2212	2208	2203	2198	2193	2188	2183	2179
60	·002174	2169	2165	2160	2155	2151	2146	2141	2137	2132
70	2128	2123	2119	2114	2110	2105	2101	2096	2092	2088
80	2083	2079	2075	2070	2066	2062	2058	2053	2049	2045
90	2041	2037	2033	2028	2024	2020	2016	2012	2008	2004
500	·002000	1996	1992	1988	1984	1980	1976	1972	1969	1965
10	1961	1957	1953	1949	1946	1942	1938	1934	1931	1927
20	1923	1919	1916	1912	1908	1905	1901	1898	1894	1890
30	·001887	1883	1880	1876	1873	1869	1866	1862	1859	1855
40	1852	1848	1845	1842	1838	1835	1832	1828	1825	1821
50	1818	1815	1812	1808	1805	1802	1799	1795	1792	1789
60	·001786	1783	1779	1776	1773	1770	1767	1764	1761	1757
70	1754	1751	1748	1745	1742	1739	1736	1733	1730	1727
80	1724	1721	1718	1715	1712	1709	1706	1704	1701	1698
90	1695	1692	1689	1086	1684	1681	1678	1675	1672	1669
600	·001667	1664	1661	1658	1656	1653	1650	1647	1645	1642
10	1639	1637	1634	1631	1629	1626	1623	1621	1618	1616
20	1613	1610	1608	1605	1603	1600	1597	1595	1592	1590
30	·001587	1585	1582	1580	1577	1575	1572	1570	1567	1565
40	1563	1560	1558	1555	1553	1550	1548	1546	1543	1541
50	1538	1536	1534	1531	1529	1527	1524	1522	1520	9517
60	·001515	1513	1511	1508	1506	1504	1502	1499	1497	1495
70	1493	1490	1488	1486	1484	1481	1479	1477	1475	1473
80	1471	1468	1466	1464	1462	1460	1458	1456	1453	1451
90	1449	1447	1445	1443	1441	1439	1437	1435	1433	1431
700	·001429	1427	1425	1422	1420	1418	1416	1414	1412	1410
10	1408	1406	1404	1403	1401	1399	1397	1395	1393	1391
20	1389	1387	1385	1383	1381	1379	1377	1376	1374	1372
30	·001370	1368	1366	1364	1362	1361	1359	1357	1355	1363
40	1351	1350	1348	1346	1344	1342	1340	1339	1337	1335
50	1333	1332	1330	1328	1326	1325	1323	1321	1319	1318
60	·001316	1314	1312	1311	1309	1307	1305	1304	1302	1300
70	1299	1297	1295	1294	1292	1290	1289	1287	1285	1284
80	1282	1280	1279	1277	1276	1274	1272	1271	1269	1267
90	1266	1264	1263	1261	1259	1258	1256	1255	1253	1252
800	·001250	1248	1247	1245	1244	1242	1241	1239	1238	1236
10	1235	1233	1232	1230	1229	1227	1225	1224	1222	1221
20	1220	1218	1217	1215	1214	1212	1211	1209	1208	1206
30	·001205	1203	1202	1200	1199	1198	1196	1195	1193	1192
40	1190	1189	1188	1186	1185	1183	1182	1181	1179	1178
50	1176	1175	1174	1172	1171	1170	1168	1167	1166	1164
60	·001163	1161	1160	1159	1157	1156	1155	1153	1152	1151
70	1149	1148	1147	1145	1144	1143	1142	1140	1139	1138
80	1136	1135	1134	1133	1131	1130	1129	1127	1126	1125
90	1124	1122	1121	1120	1119	1117	1116	1115	1114	1112
900	·001111	1110	1109	1107	1106	1105	1104	1103	1101	1100
10	1099	1098	1096	1095	1094	1093	1092	1091	1089	1088
20	1087	1086	1085	1083	1082	1081	1080	1079	1078	1076
30	·001075	1074	1073	1072	1071	1070	1068	1067	1066	1065
40	1064	1063	1062	1060	1059	1058	1057	1056	1055	1054
50	1053	1052	1050	1049	1048	1047	1046	1045	1044	1043
60	·001042	1041	1040	1038	1037	1036	1035	1034	1033	1032
70	1031	1030	1029	1028	1027	1026	1025	1024	1022	1021
80	1020	1019	1018	1017	1016	1015	1014	1013	1012	1011
90	1010	1009	1008	1007	1006	1005	1004	1003	1002	1001
1000	·001000	0009990	9980	9970	9960	9950	9940	9930	9921	9911
10	0009900	9891	9881	9872	9862	9852	9843	9833	9823	9814
20	9804	9794	9785	9775	9766	9756	9747	9737	9728	9718
30	9709	9699	9690	9681	9671	9662	9653	9643	9634	9625
40	9615	9606	9597	9588	9579	9569	9560	9551	9542	9533
50	0009524	9515	9506	9497	9488	9479	9470	9461	9452	9443

To facilitate the calculation of the corrections to widths, and therefore of the increments to quality, I have arranged a table, available as well when the ground surface is examined in the approximate manner just described, as when the more detailed levels are taken for setting out the earthworks of the line. This table is annexed, and its use will become familiar from following the steps of an example:—

Taking the measurements from the form of level book attached to the paper on "Setting out Railways," already referred to (see the Journal for September, p. 277), we find at the beginning of the first chain's length,

$$B + r\,C = 30{\cdot}75\,;\ H = 1{\cdot}9\,;\ -H' = 2{\cdot}2\,;\ r = 1{\cdot}5.$$

Then 1·5 × 1·9 = 2·85 ; and 1·5 × 2·5 = 3·3.

Entering the table with 2·85, I find opposite 285 the tabular number ·903509; from which, as there are two decimal places in the number 2·85, I cut off two decimals and have for rH ...... 2·85 ...... ·3509.
And in the same way, entering the table with $B + rC$ = 30·8, I obtain 30·8 .... .0324 ; and taking the difference of these two tabular numbers, ·3509 — ·3324 = ·3086, which, found in the table, corresponds to 3·14, the value of x, additive.

On the other side, for the value of $-x'$.

rH' = 3·3 tabular number 3030
x ...... 30·8 .... ·0324

·3354, which corresponds to 2·98.

At the other end of the first chain, $B + rC'$ = 24·45 ; H = 3 ; H' = 1·9.

3 × 1½ = 4·5 .. Tab. No. ..	·2222	1·9 × 1½ Tab. No. for 2·85 ..	·3509
deduct for, 24·5 .... do.	·0408	add ..	·0409
x, additive = 5·51	·1814	x' subtractive = 2·55	·3917

These examples show the use of the table in setting out the earthwork.

For values of x, x', &c., as elements of calculation for correcting the quantity, when the *rate* of inclination of the ground surface simply is taken in the field, this rate of inclination should be expressed so as to indicate a vertical height in terms of 1000 parts horizontal:—Thus, if in a chain's length of 50 feet, the inclination of the ground amounts to 1·25 feet, the ratio expressing the vertical height in terms of 1000 parts horizontal is 25. Also, if in the length of a Gunter's chain = 66 feet, the rise or fall measured 2·2 feet, the ratio in 1000 parts would be 33·3. This is a common Rule of Three question, thus:—

50 : 1·25 :: 1000 : 25

which, when using a Gunter's chain, and a level-staff divided into feet and decimals, is abbreviated by converting the height or difference of level, read off on the latter, into links, and multiplying that equivalent by 10. Let us call this ratio of the inclination of the ground b ; — r the ratio of slopes of cutting and embankment, as before, as likewise the other characters which follow.

The table should be entered with a number, the result of the formula $\frac{r \times b \times (B + rC)}{1000}$, from the tabular number of which we must *subtract* the tabular number corresponding to the value $(B + rC)$, to obtain the value of x; and, on the other hand, we must *add* to get the value of x'

Thus, suppose b = 33·3 ; and $B + rC$ = 30.8 ; r = 1·5 ;

$$\frac{rb(B + rC)}{1000} = \frac{33{\cdot}3 \times 1{\cdot}5 \times 30{\cdot}8}{1000} = 1{\cdot}54 \ldots \text{Tab. No.} \ldots\ {\cdot}6494$$

30·8 ....deduct ·0335

x = ... 1·03 .... ·6169

x' = ... 1·47 .... ·6819

Again, if b = 7·64 ; r = 2 ; $B + rC$ = 35·2 ;

$$\frac{7{\cdot}64 \times 2 \times 35{\cdot}2}{1000} = {\cdot}538 \ldots \text{Tab. No.} \ldots\ {\cdot}1859$$

35·2 ....deduct ·0284

x additive 6·35 .... ·1575

x' subtractive 4·67 .... ·2143

It is not altogether foreign to the subject of this paper to present some applications of the prismoidal formula, which, as cases of frequent occurrence, are deserving of being noted for their simplicity, and for the brevity of their solution in numbers; especially as they are seldom, if ever, met with in works on mensuration.

1. In a triangular prismoid, of which the area of the base is called B, and the three heights perpendicular to the plane of that base h, h', and h'',

$$\text{the solidity} = B\,\frac{(h + h' + h'')}{3}.$$

2. In a prismoid with a trapezoidal base; divide this base into two triangles, and call one of the parallel sides of the trapezoid as the base of each triangle; then add together twice the heights above the base of one triangle, to once the height above the base of the other triangle, and multiply this sum by one-sixth the area of the base of the triangle; this done for each triangle, and the results added together will give the solidity of the prismoid. Thus, if h, h', are the heights above the base at the ends of one of the parallel sides of the trapezoid; and h'', h''', the heights at the ends of the opposite parallel side; B, and B', being the areas of the triangles, having those sides for their bases respectively; then

$$\text{the solidity} = B\,\frac{(2h + 2h' + h'' + h''')}{6} + B'\,\frac{(2h'' + 2h''' + h + h')}{6}.$$

This solid may have one, two, three, or four heights, and the formula admits of further simplication according to the relation of the heights to each other.

3. When the four heights, being unequal, the base of the prismoid becomes a parallelogram of which the area = B,

$$\text{the solidity} = B\,\frac{(h + h' + h'' + h''')}{4}.$$

This last formula furnishes the means of determining the solidity of a body of any extent whatever, terminated by an irregular surface, but of which the base is a parallelogram. With this view, we must suppose it divided by two systems of equidistant vertical planes, parallel respectively to each other and to the sides of the parallelogram; and if l = one of the equal parts, into which one of the sides of the parallelogram is divided,

h, h_1, h_2, h_3, h_4, &c., the series of vertical dimensions taken through points at the distances l, in the first vertical plane;

$h', h'_1, h'_2, h_3', h'_4$, &c., the corresponding vertical dimensions in the second vertical plane; and so on.

Then the area of each plane is,

$$A = \frac{l}{2}\left(h + 2h_1 + 2h_2 + 2h_3 + \ldots \frac{h}{n}\right)$$

$$A' = \frac{l}{2}\left(h' + 2h'_1 + 2h'_2 + 2h'_3 + \ldots \frac{h'}{n}\right);$$

and so on. Then if L represent the perpendicular distance between the vertical parallel planes,

$$\text{the solidity} = \frac{L}{2}\left(A + 2A' + 2A'' + 2A''' + \ldots\ldots\ldots\ldots A^n\right).$$

These theorems may readily be deduced as corollaries from the prismoidal theorem, but they are also capable of an independent elementary proof.—See *Puissant Traité de Topographie.*

4. If a line of slope (of a single slope) turns at right angles to its original direction, the solidity of the angular portion, when h = height at the angle, and r the ratio of the slope, is

$$rh \times \frac{rh^2}{3}$$

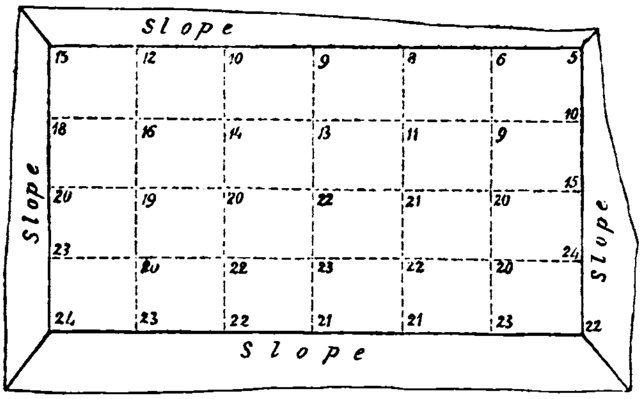
5. If the direction of a double slope and bottom, as a ditch or trench, turns off at right angles, then b being the width of the bottom, the solidity of the angular portion is $(3b + 6rh)\,\frac{bh + rh^2}{3}$.

Example.

In erecting some Iron Works, it became necessary to provide a proper foundation for a quantity of ponderous machinery, by removing a considerable depth of cinders, rubbish, and loose ground over the whole site of the proposed buildings, which covered a rectangular space of 150 feet × 80 feet.

To calculate the quantity of earthwork to be executed:—The parallelogram being set out, each of its long sides was divided into six equal parts of 25 feet, and each of the short sides into four equal parts of 20 feet. Note,—*the calculation is much shortened by dividing each side into an* EVEN *number of equal parts.* This is shown on the figure.

The necessary depth was then ascertained by boring, and a series of levels over the surface of the ground were taken, as shown by the dotted lines, which being reduced to the plane at the intended depth, as a datum, in the usual way, gave the dimensions as figured in the diagram. The sides of the excavation were to be finished with slopes of 1 to 1.



Calculation of Volume.

Heights at angles..	15+ 5+22+24 = 66..	Tab. No. 1..	0·8148
Exterior heights ..	12+10+ 9+ 8+ 6 = 45		
	23+22+21+21+23 = 110		
	18+20+23........ = 61		
	10+15+24........ = 49		
	265..	Tab. No. 2..	6·119
Interior heights ..	16+14+13+11+ 9 = 63		·1235
	19+20+22+21+20 = 102		
	20+22+23+22+20 = 107		13·3333
	272..	Tab. No. 4..	·0088
			20·7894
	¾×20×25=375..........	multiplied....	375

Content of central part .... cubic yards .... 7796·02

Slopes.

Sides.

Heights at ends.	15	Table No. 1.	2.7778	16·1728
	5	,,	·3086	
	24	,,	7·1111	
	22	,,	5 9753	
Heights at the 3rd and 5th points of division, or the *odd* numbers.	10	Table No. 2.	2·4691	
	8	,,	1·5802	
	22	,,	11·9506	
	21	,,	10·8889	
Heights at the 2nd 4th, and 6th points of division, or the *even* numbers.	12	Table No. 4.	7·1111	
	9	,,	4·0000	
	6	,,	1·7778	
	23	,,	26 1235	
	21	,,	21 7778	
	23	,,	26·1235	
			129·9753	

* 25/2 = 100/8 .... cubic yards 1624·7 ... 1624·7

Ends.

15, 24, 5, 22	as above..	16·1728	
20	Table No. 2.	9·8765	
15	,,	5·5556	
18	Table No. 4.	16·0000	
23	,,	26·1235	
10	,,	4·9384	
24	,,	28 4414	
		107·1112	

* 20/2 .... cubic yards 1071·112 ... 1071·11

Slopes at the angles.

		Tab. No. r^2h	
15	Table 1.	2·7778×15= 41·667	
24	,,	7·1111×24=170 666	
5	,,	·3086× 5= 1 543	
22	,,	5·9753×22=131·457	
			345 333
		Total	10837·163

* Since the tables are calculated to give 'both' slopes of a cutting, the mult'plier must be divided by 2, to obtain the contents of 'one' slope.

It is to be observed that a more rigorous calculation, with the use of Table 3, which would involve just double the number of figures, gives, as the content of the slopes along the sides, a smaller quantity by 6¼ cube yards, and of the slopes along the ends a smaller quantity by 42 cube yards and if extreme accuracy is desired, such form of calculation must be followed, as explained p. 17-19 of the introduction to my tables. It is only, however, when each height differs from being an aritmethical mean between the two adjacent heights, that this more lengthened operation can be required; and such a difference may be estimated by inspection, to enable the calculator to judge whether it is desirable to incur the trouble.

JOHN HUGHES, A. I. C. E.

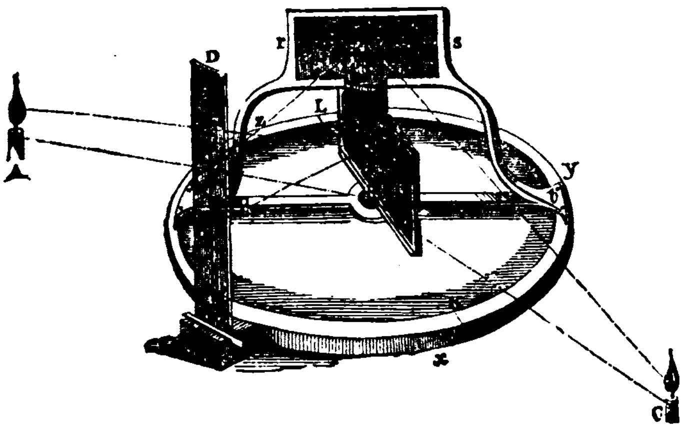
1, *Lancaster Place.*

A NEW MINING SURVEYING INSTRUMENT.

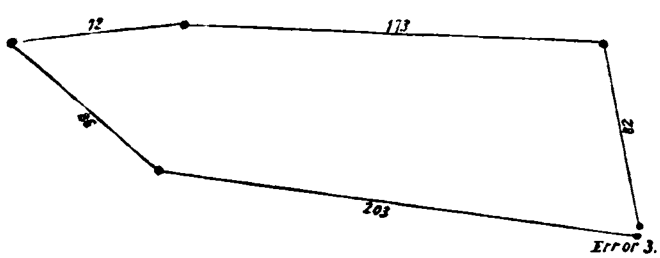
SIR—I beg to offer to your notice, and through your valuable Journal to that of practical surveyors and engineers, a sketch of a model instrument for taking horizontal angles, which I think is new, and likely to become exceedingly useful, although it is but a modification of the principle upon which the quadrant and sextant are constructed. I have been led to the construction of the model, by constant experience for the last 20 years, of the difficulty and uncertainty of the use of the dial or compass for underground surveying. Practical men need no mention of these, but for the information of those not actually conversant with subterraneous surveying, I may mention briefly the principal difficulties,—there is first the attraction of the needle by the tram rails (now generally composed of wrought iron) which renders it necessary at each station of the instrument, to take them up for a distance (to make sure work) of 5 to 7 yards on each side of it—a laborious operation, and much impeding the mining operations by obstructing the wagon-way, besides occupying much of the time of the surveyor, who has to await the pulling up and removal of the rails. The next difficulty is the slow but progressive variation of the needle rendering a colliery plan of 9 or 10 years old altogether inaccurate, and therefore making it necessary to alter the meridians (generally numerous on a working colliery plan) or to make allowances in the observations taking during every survey made after the lapse of such a period of time. Then follow local attractions in the stratum of the coal itself or in the strata above or below it, often causing a difference of 2° to 3° between a fore and a back observation on the same line. Another is the gradual weakening of a needle in constant use, and its consequent sluggish working causing great loss of time, and great uncertainty—these are formidable evils, and other minor ones might be adduced if necessary.

It may be said with perfect truth that horizontal angles may be readily taken by a common circumferentor, or by a theodolite,—but of these the latter is too bulky, heavy, and complicated an instrument to be admissible into or usable in a coal mine, under ordinary circumstances, and there is a radical defect in the former which completely destroys its efficiency in mine surveying. It consists in the instability of the instrument and its consequent uncertainty during the movement of the upper upon the lower limb,—and if by way of correcting this, the instrument be furnished with a double set of sights, one for the back and the other for the fore observation, in the manner of those of early construction—this difficulty occurs, that the surveyor having fixed one pair of sights, must go to the other side of the instrument in a gallery very often less than three feet high, and than five feet in width (and this width occupied by the legs and other parts of the instrument itself) to take the other observation, and afterwards he must go back again to take the first observation again to assure himself that the instrument has not shifted during the adjustment of the moveable sights for the second observation. If he find, as is most probable, that it has stirred, the observation must be repeated perhaps several times, and this in a space where it is next to impossible to move without disturbing the instrument. Even two operators, one on each side of it, would be useless, as they would be in the way in nine cases out of ten of each others observation, and would obstruct it by intercepting the view of the object.

By the instrument of which the above is a sketch, both objects are brought to the eye, as by a quadrant, at the same vertical line, and seen at the same time, and the angle indicated by the vernier, without any of the uncertainty and difficulty I have mentioned as besetting the use of the common dial and that of the circumferentor.



Briefly to illustrate its use, permit me to refer you to the sketch, supposing it requisite to take the angle formed by the two lines joining respectively A B, B C, the instrument is placed at the angle, and the limb *x y z*, which is flat, circular, and divided on the outer edge into 720 or half degrees, each indicating in an observation a whole degree—this limb is then turned on a joint below, admitting horizontal motion, until the candle A is reflected from the mirror B, to the eye of the observer placed anywhere opposite the vertical line D E—this mirror B is fixed vertically on the lower limb, with the silvered surface exactly in the centre. Then the upper limb is so adjusted that the candle C is also reflected from the mirror G (which is fixed vertically to this limb, and whose centre of motion is in the plane of the mirror B.) to the eye of the observer on the line *d e*, of the sight D E, during this adjustment if any movement occurs in the instrument, it is instantly detected and adjusted by the observer without change of place, without difficulty, and in the least imaginable time. The angle required is then indicated by the vernier at either end of the limb *q, r, s, t*, at *q* or *t*. To test the efficiency of the instrument, I made the subjoined survey with it, of a small but very hilly sloping piece of ground, of which I subjoin the plotting showing the error, which considering the imperfection of the model, will be considered, I think, very small.



The model is constructed, the lower limb of wood and divided by the hand, and the upper one of brass, and with the whole fitting constructed by a workman unaccustomed to instrument making. I propose in the perfect instrument to place two levels at right angles on the lower limb, to fix it upon a ball and socket joint or parallel plates to facilitate the levelling thereof, and to apply rack-work capable of being easily thrown in and out of geer to the upper limb, and similar racks and a champ screw to the sight D E, which is moveable round the lower limb, and which in the model is a slip of glass—for this I propose to substitute an ordinary sight with a vertical thin wire in lieu of the line on the glass. I should mention that the mirrors are marked by vertical lines on the silvered surfaces, and that these lines are in the axis of motion of the upper mirror. I should mention that in the graduation of the lower limb, there are two opposite points marked zero, situated in the line of the silvered surface of mirror B, and marked in the sketch K L respectively.

I remain, Sir, your most obedient servant,

William Peace.

Haigh Colliery, Wigan, October 9, 1846.

ENCAUSTIC-PAINTING, WITH WAX, RESIN, AND OIL.

By Mr. Linton.

(Communicated to the Commissioners of Fine Arts.)

Wax was the most important ingredient in the vehicles for painting employed by the ancients. Its use is traceable from the early ages of Egypt,[1] and throughout those of Greek and Roman art. It was extensively and almost exclusively used by the early Christian painters, and continued to be commonly employed till a late period in the middle ages. There is also abundant evidence of the use of resins by the ancients, and the employment of such substances among the ingredients for painting, as well as for varnishes, was continued after the invention and improvement of oil-painting. The process which has been found most satisfactory is that which excludes the fixed oils as much as possible, substituting for them wax, resin, and an essential oil. As a first condition affecting the durability and brilliancy of the work, a ground of pure white is recommended. In this, the practice of remote antiquity has been confirmed by the best modern authorities. The Egyptians, in the preparation of the surface for painting on walls and on mummy cases, have left proofs of the estimation in which white grounds were held in the earliest times. The practice of the Greeks and Romans is exemplified by the prepared white tablet which was found among the ruins of Herculaneum. Aristotle among the ancients, and Leonardo da Vinci and Armenini among modern writers, speak of white grounds as essential to the brightness and durability of pictures. Caravaggio and others of the "Tenebrosi," on the contrary, who were instrumental to the decline of art by employing dark grounds, have proved that the effects of time are accelerated by that practice. Many of the works of Tintoret have suffered from the same cause.

In the method about to be described, wax with resin may be considered, as a substitute for a portion of the oil usually employed; "the object being," as a French chemist observes, "to replace an alterable recipient for the colours, such as oil is, by one whose nature it is to resist the action of time and the agents of destruction."[2]

The Process.—Secure a stout and well-pumiced canvas, free from size and gummy matter. Fasten it slightly on the stretcher, with the smooth surface undermost. Dissolve any quantity of bleached wax in double its weight of oil of turpentine, and saturate the canvas with the solution while hot, and near the fire. Then take the canvas off the frame and stretch and fix it properly, the smooth side being now in front for the reception of the ground.

The Vehicle.—Prepare the vehicle, which is to be exclusively employed throughout both ground and picture, in the following proportions:—

3 ounces of essential oil (of turpentine, lavender, or rosemary, &c.)
2 „ resin (mastic, Copal, or Damara, &c.)
1 „ bleached bees' wax.

Place them in a glazed pot near the fire, occasionally stirring them with a stick, until the solution is completed. When cool it will be a magylp ready for use.

Procure a quantity of white-lead ground in oil; that of the shops may answer the purpose for the two first coats, but flake white is preferable, and is indispensable in the two last layers. Mix a portion of the vehicle with the lead, and reduce to a creamy consistence by the addition of turpentine essence.

Ground.—Spread, with a large flat knife or trowel, four coats of this white-lead cream over the canvas as smoothly as possible, allowing several hours to intervene between the layers.

Picture.—In proceeding with the picture, the usual tube[3] or bladder-colours of colourmen, ground in oil, may be employed (unless the painter have this labour performed at home), while the vehicle may be placed on the palette near the colours, in the usual way, to be ready as a diluent. If a rapidly obtained *impasto* be desired, a portion of the vehicle must be mixed with the colour, which in a very short time will be found to have obtained a consistence almost fit for modelling.[4] The vehicle can also be thinned at pleasure by additional oil of turpentine, which will enable it to work more freely; or it may be softened and retarded in drying by a slight addition of plain oil; or stiffened by replacing it near the fire to diminish the essence. The most careless or lavish use of it cannot be followed by any injurious results, since, after the essential oil has evaporated, the ingredients subside into a firm and unchangeable mass among the colours, without either shrinking or losing the forms into which they have been wrought by the hand of the painter. The essential oil has free egress, by the agency of the wax, through the back of the canvas, as well as through the front of the picture.

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[1] See, among other examples, No. 31 in the British Museum—a small funereal group of painted sculpture.

[2] Durosiez, ib. p. 12.—I took a quantity of the best flake white ground in oil, and thinning it with nut oil, I put several layers on a prepared millboard. From the same parcel of oil white lead I took another portion, and diluting it to a working consistence with wax cream (wax and oil of turpentine) I put the same number of layers on another part of the millboard. In a few weeks the portion which was diluted with additional oil, had become of a decidedly yellow tint, while that which was mixed with the wax cream remained as purely white as at first.

[3] Bladder-colours become fat and rancid from the access of air in the course of time, and many of the colours in tubes oxidize or blacken in a few months; among the latter I have found white lead, Naples yellow, yellow ochre, raw sienna, &c., so affected.

[4] It may be as well to remark that an excessive application of essential oil in painting has a tendency to injure the tenacity of the paint, as may be seen in what house-painters term bad "flatting." The rapid evaporation of the essence from the more substantial materials with which it is combined breaks up, in some degree, their cohesiveness.

Pictures painted with oil only, or with common magylp, consist of a succession of skins or layers of paint, more or less cut off from mutual intercourse; but the cero-resinous medium keeps the whole substance in a constant state of intercommunicative moisture during the progress of the work. The painter can pursue his operations, without delay, to any stage he may think proper; he may also return to them at pleasure; and he will find himself relieved from the necessity of such a preparative as "oiling out," an injurious and disagreeable practice, often called for by the greasy oozings through the surface or outer skin of the oil picture. It may also be remarked that the scrapings, glazings in, and rubbings off for texture, which are so often resorted to where oil alone has been used, are wholly unnecessary in this system, which, by humouring the vehicle to the required consistence, yields all the means for a varied manipulation that can be desired.[5]

Encaustic.—When the picture is completed, a short time being allowed for the evaporation of any excess of essential oil which may remain in those portions of the work which have been recently loaded with colour, it should be gradually moved towards and held in front of a fire until the surface has obtained an equal gloss, care being taken that it does not fry by too sudden or close an approximation; it must then be withdrawn to set and cool; after which it must be rubbed with fine linen cloths or with silk until a polish is produced. If the picture be large, a *cauterium*, or chafing-dish, may be moved in front of it at a careful distance (from 2 feet to 18 inches or a foot, but not nearer), in order to obtain the required gloss. Should the picture have been painted upon millboard or panel, the evaporation of the essential oil must necessarily take place from the surface only; the capacity of the picture for retaining heat being thus greatly increased, the latter will act, if the encaustic or "burning in" process, be performed gradually and slowly upon the resin, as well as the wax and oil, and effect a thorough fusion of the whole medium, which will result in a most brilliant and durable enamel, more resembling a vitrified than a waxed surface. The more perfect the desiccation, the more perfect and durable will be the gloss. The reason why encaustic surfaces frequently become dull is, that the gloss is produced before the essence has entirely evaporated, the after-evaporation through the wax enamel reproducing the flat and porous surface. "Its lustre," says Professor Tingry, "is equal to that of varnish, without having any of its inconveniences. A wax surface stands shocks, a varnished one does not. If any accident alters the polish of wax, rub it with a piece of fine cork." To clean an encaustic picture, M. Durosiez gives the following directions:—"Remove the dust, wash it well with alcohol and water, then with pure water, dry it, expose it to heat (in the mode described), and polish with cloths as at first." The encaustic surface has more atmosphere than very new varnish,[6] and is sufficiently transparent to display the deepest shadows to advantage; it does not require periodical additions, like fresh varnishings; and it is not subject to chill, like most of the essential oil solutions of the resins. "Encaustic pictures," says Montabert,[7] "never alter; they can be retouched; they are luminous and transparent, and possess all the excellencies of oil-painting, combined with greater durability."[8]

As an addendum to the description of the process, a few remarks on the materials of which it consists may not, perhaps, be thought unnecessary. *Oil of Turpentine* being the most available essence in this country, and answering the requisite artistic purposes quite as well as either rosemary or lavender, it may not be amiss to retain it for the process. The best bleached bees-wax that can be procured is another required ingredient. Pure wax from the comb, bleached by exposure to the light,[9] is to be preferred to the shop white wax, as the latter is usually adulterated with tallow. Wax is said by many to run when used in pictures, and by others to be subject to crack. Professor Brande, however, informs us in his "Chemistry" that this substance will not melt under 154½° Fahrenheit, a degree of heat scarcely ever attained by the sun in this country: this statement, which differs but slightly from that of other eminent chemists, ought to satisfy the most suspicious that the confidence placed in wax by the Greeks, Romans, and Egyptians, denizens of far hotter climates than ours, was not that of ignorance. Besides, when in combination with other matters, wax is so notorious for its powers of adhesion, that a vastly increased degree of heat would be required to fuse it when so circumstanced. I have several times exposed sketches, painted with this cero-resinous vehicle united to colours ground in oil, to a stove heat of 160° Fahrenheit after the essential oil had entirely evaporated, without the slightest running of the surfaces. And in forcing the heat still higher upon a layer of white-lead ground in oil added to the vehicle, the white became very slightly tinged with yellow (from the partial combustion of the oil, as I afterwards proved) without any other change whatever.[10] As to the disposition of wax to crack in pictures, it may be observed that unless it be employed in some layers and excluded from others, cracking cannot possibly ensue. Since, however, there are no two substances in the painter's *matériel* which are characterized by similar dispositions to contract and expand, extreme caution should be adopted in the juxta-position of differently constituted vehicles in the several layers of a picture. Varnish over unhardened oil, drying oil over the same, or wax over any of the three, would be very likely to produce cracking. Dr. Roux says that "wax does not contract like the unctuous oils;"[11] and the Italians consider that new tempera as well as oil-paintings are subject to crack in extremely dry seasons, but that wax rests undisturbed. Among the resins suitable to this process there is abundant choice. Damara is a favourite on the continent. It is very clear and bright, and does not crack when spread alone as an essence varnish over a wax picture. Mastic, which has a little more colour, has long been a favourite with painters, but it is very subject to chill (a failing which has been attributed to unsound watery tears[12]) when made with volatile only. Correggio and the Lombard painters are said by Armenini to have dissolved it in fixed oil for a glazing vehicle or varnish. Sandrac was a favourite with the old masters; but I found it work very harshly without fixed oil. Elemi is another continental favourite. It is slightly coloured, but is said to be tough in varnish. (Aiken.) Anime is difficult to dissolve; "it is more brittle and less solid than copal. (Tingry.) The fluid resins, Venice and Chio turpentines, with Canada and Capivi balsams, may any of them be used to advantage in this process, due consideration being had to the excess of essential oil which they contain.[13] The solution of the harder resins seems to have been better understood in former times. To dissolve copal effectually has ever been considered a difficult task; and perhaps a greater value has been placed on the resin on that account. The power of wax in consolidating the feeblest resins seems to place every requisite means at our command without undue labour or difficulty. And yet the superior qualities of copal, its toughness, its brilliancy, its consistence, and its durability, single it out as the most desirable of all resins to bring into subjection. Bonanni, Tingry, &c., &c., have devoted much time and skill to its solution, and have succeeded variously. Oil of turpentine, which Tingry pronounces (because it is a resinous essence) the most perfect solvent for resinous substances, and especially for copal, requires several months exposure to light in order to imbue it with the requisite powers. The essence having attained these qualities, will, when made hot, and in a warm room, take up the powdered resin, if carefully sprinkled into it and stirred up at the same time. If the essence be new, the solution is almost impracticable. When copal has been fused and thrown into cold water before levigation, it dissolves more readily. It has sometimes been fused a second time before solution, but this is an operation which must have a powerful effect on its best qualities, and it is to be hoped that the least injurious mode may be generally adopted. The oils of rosemary and lavender have often been successful where oil of turpentine of a sufficient age has not been available. If the caoutchouc portion (so called) of the resin continue to float in transparent masses after the essence has cooled, time and light only can perfect the union. The fluid resins readily take up an eighth of their weight of copal. I could never effect a stronger solution with them; but with three ounces of turpentine oil alone I have completely dissolved an ounce of the pale copal unfused; a proportion which is quite strong enough for any useful purpose. One ounce of copal in eight ounces of essence is the usual proportion in Tingry; but one in three or four is necessary to make a good cero-resinous magylp. I may observe that the above solution of one to three dried very rapidly; and that it possessed such a degree of toughness and flexibility that five stout coats of it spread on a broad strip of letter paper, and hardened, exhibited not the slightest symptom of cracking when closely wrapped round so small an object as a common lead pencil. If every painter desirous of possessing real copal varnish would place a quart of oil of turpentine in his window, every three or four months, in a clear glass bottle, leaving an interval of one or two inches between the cork and the essence, removing each bottle as it became fit for use (in eight or twelve months as it might happen), he would have every chance of continued supplies of the varnish for his studio; since a pestle and mortar, a common brown mug to hold the essence, and an Argand chemist's lamp to receive the mug, constitute all the apparatus requisite to perform the operation both with precision and safety.

William Linton.

7, Lodge-place, Regent's Park, August, 1846.

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5 If the add'tion of a little oil or extra turpentine essence be required, and the magylping property be overpowered, recourse must be had to the palette tina.

Dr. Bachoffner, in allusion to Sir Humphry Davy's having found the colours of the ancients (at Pompeii) to be similar to those now in use, thinks "that modern vehicles are at fault."—'Chemistry applied to the Arts."

6 See Boschini's remarks on varnish glare, and the aversion in which the Venetians held it, in the "Third Report of Commission of Fine Arts."

7 "Traité complet de la Peinture."

8 For a wax varnish: "Take three parts white wax and one part resin; melt together; apply over the picture, and polish with cloths."—'Antologia Romana.'

9 The blocks of yellow wax may be bleached as follows: Cut them into shavings upon a carpenter's plane inverted; and then expose them to the sun in an unsmoky atmosphere, occasionally turning over and moistening them with clean water. In the steady and potent light of Italy, the bleaching operation is completed in three or four days, as I have many times witnessed; but in our variable climate it cannot be effected without more time and trouble. The brown wax of commerce is frequently adulterated with common resin. The dark-coloured old combs are almost unbleachable, and their substance is of a less tenacious or waxy character, as it is mixed with bee bread and other impurities. Fine bees-wax may always be obtained of Mr. Milton, the eminent apiarian, in Weymouth-street, Portland-place.

10 Cennini and Baldinucci give recipes for cements of wax and resin only for broken marbles, in which the wax is proportioned to the resin as three to one.

11 See the Third Report.

12 J. Scheffer's "Graphice," Norimbergo, 1669.

13 In applying these balsams and turpentines to pictures it has been advised to evaporate by heat the excess of essential oil which renders them fluid at the common temperature of the air, and to re-dissolve them in some more evaporable essence. An undrying principle may be productive of as much mischief in a resinous as in an oleaginous vehicle.

CANAL OF THE ISTHMUS OF PANAMA.

The following translation of extracts from the report of Napoleon Gafella, an engineer appointed by the French Government to survey the Isthmus of Panama, is taken from the *Journal of the Franklin Institute*:—

The remarkable isthmus which unites the two Americas and extends between the Gulf of Mexico and the Pacific Ocean, to a length of 1430 miles, in a direction from W.N.W. to E.S.E., presents along this enormous length a variable width. From the mouth of the Guazacoalco, its point of junction with North America, where it has a width of 137 miles, it continues narrowing regularly enough, with the exception of the two large promontories of Yutacan and Central America, to its other extremity, towards the Gulf of Darien, where it is united to South America. It is towards this latter portion, where it is called more particularly the Isthmus of Panama, that it attains its minimum width. From the mouth of the Caimito, on the Pacific Ocean, to the embouchure of the Chagres on the Atlantic, the distance is but 36 miles; but the minimum width appears to be a little more to the eastward, between the bay of Mandingo or San Blas, on the Caribbean sea, and the shore of the Pacific Ocean, near the embouchure of the Rio Chepo, where the distance, according to the map, is but 31 miles. The chain of mountains which extends in a direction nearly north and south, the whole length of the two Americas, from the icy seas of the north pole to Cape Horn, presents along nearly its whole length a considerable elevation. Its peaks are only surpassed in height by the summits of the highest of the Himalayas, and even its vast plateaux have an elevation superior to that of the highest mountains of the interior of France. This chain extends, without any discontinuity, the whole length of the isthmus, but then as the breadth of the land diminishes, so the ridge of the chain sinks considerably, and presents some depressions, of which the height above the ocean is less than that overcome by some of the European canals already constructed. One of these remarkable depressions exists in the neighbourhood of Panama—not at the point where the isthmus is narrowest, but a little to the westward, where, however, it is narrower than at Panama. In examining the configuration of the isthmus from west to east, it will be remarked that, passing from the state of Costa Rica (Central America) into the province of Veraqua (New Granada), under the 85th degree of west longitude, 8 degrees to the westward central ridge dividing the waters flowing into the two oceans, appears to break off suddenly at the steep and precipitous peaks of the Trinity (Cerro de la Trinidad). There commences the depression of which I have spoken, and which extends a distance of 25 miles, to the hills of Ormigueros. The ridge then rises by degrees, and attains, opposite Porto Bello, and near the Gulf of San Blas, its previous height. Along this distance there are a number of points whose elevation varies from 425 to 525 feet, between which the ridge rises but little, and forms hillocks, and not peaks or elevated masses. This depression of the central chain is, then, one of the first and most evident observations which the explorer makes; and it has been noticed by nearly all those who have surveyed the isthmus; Mr. Lloyd points it out for the line of a canal; and it is there, also, that Mr. Morel, the agent of the Salomon Company, has laid down his route. It is evidently there that the summit level of the maritime communication to be opened between the two oceans, should be placed. Unfortunately, those who have hitherto visited the isthmus, have only judged approximatively of the height of this portion of the chain, and that by a simple visual observation, made without employing any instrument, and mostly at long distances; and taking, without doubt, as points of comparison, the elevated mountains of the Trinity, and other masses of a considerable elevation, situated more to the eastward; those of the Cerro Cabra, which are 1614 feet high, and those of the Cerro Grande of Gorgona, which rise to a height of 1017 feet. Thence, doubtlessly, comes the erroneous opinion spread abroad, on the faith of some navigators, that the central chain uniting the elevated table land of Mexico with the Andes of Peru, ceases entirely in the portion of the country of which we are now speaking; and is cut by a transversal valley, where man will have almost nothing to do to establish a navigable communication between the two oceans. Thence, also, without doubt, the extraordinary assertion advanced by the Salomon Company, that this depression of the chain offers a point of passage situated only 37 feet above the mean height of the sea at Panama, a point which the company naturally chose for carrying across the summit level of the canal which they projected. From the sides of the Cerra de la Trinidad flow three principal streams, of which the most important, the Caimito, empties itself into the Pacific 14 miles west of Panama. The two other streams, which flow towards the Atlantic, are the Cano Quebrado and the Rio Trinidad—rising at nearly the same point, they separate as they advance. In the triangular space comprised between them, the laws of nature, which, throughout America, have placed the ridge of separation of the waters flowing into the two oceans, nearer the western side, appears to have been maintained. The wide space which separates the bed of the Trinidad from the base of the spur, is occupied by vast and, for the most part, unbroken plains, from the middle of which rise some isolated hillocks. One does not there meet with the water-courses which might be expected from their extent, but many swamps, and even deep lakes, communicating with the Rio Trinidad by small natural canals, called *esteros*. In these plains is found the large lake of *Vino tinto*, observed by Mr. Morel, which is upwards of a league in diameter. Here also are found, near the mouth of the river, the swamps of *Agua Clara*, which have in some places, as I have been assured, a depth of water of 42 feet.

Besides these streams, there is another on the western slope, flowing directly into the Pacific; it is the Rio Grande, situated between the Caimito and Panama, and having its mouth 1½ miles west of that city. It is indeed a stream of no great magnitude, the upper portions of which are completely dry during some months of the year; but it presents a characteristic which it has in common with other affluents of the Pacific Ocean, which is, that the lower portion of its bed has but a slight descent and great width, so that the tide mounts it to a considerable distance, and thus forms an arm of the sea (*estero*) intruding into the land, with a depth varying from 25 to 33 feet, and sometimes even more, which offers facilities for navigation, though only during high water, and as far as the tide flows. It is to this characteristic that the Rio Grande owes its name, though in fact it is but a brook. Alongside of the Rio Grande is another little ravine, pouring its waters directly into the sea. This is the Rio Farvan, having, towards its mouth, a wide and deep bed, which, at this point, is only separated from the Rio Grande by a hill, around which its waters are forced by high tides, flowing into the Alvine marshes, through which the road from Panama to Chorera passes, thus mingling the waters of the two creeks.

This feature of a great diminution of fall near the embouchure of the stream, is still more perceptible on the Atlantic slope. The Chagres, which is undoubtedly the most important and most voluminous stream of water of this portion of the isthmus, presents it in a very striking manner. The tide of the Atlantic, which rises but from 13 to 15 inches, ascends the river a distance of 17 miles; and is navigable, but with some difficulty, beyond a distance of 18 miles from its mouth. Thence it can be ascended only by poling, on account of the rapidity of the current and the irregularity of the bottom. Laden boats ascend it as far as Gorgona and Crucés, but in the dry season (from December to June) they are obliged to unload the larger barques on a beach near the mouth of the Cano Quebrado, and to load again in smaller boats; and even with these they have great difficulty in reaching Crucés. With the exception of the Rio Chagres, the other rivers of the isthmus can hardly be said to be navigable, and none of them can be made useful for the purposes of navigation.

The waters flowing from the central chain, at its point of depression, are divided, as we have seen, between two basons: that of the Caimito upon the Pacific slope, and that of the Rio Chagres, or rather of the Cano Quebrado, upon the Atlantic slope. It is then between these two basins, that the point for the passage of a canal of communication between the two oceans, is to be sought. It is along their tributaries that we must look for the valleys where the canal should pass; and finally, it is in the neighbourhood of the localities where their waters empty into the sea—that is, near the mouths of the rivers Caimito and the Chagres—that we must seek the points of communication of the canal itself with the two oceans; the bars which always form at the points where the running waters of rivers meet the still waters of the ocean, rendering it necessary, as a general rule, to avoid carrying a great line of navigation to those points.

The Rio Chagres has, in fact, at its mouth, a bar with a depth of water of but 18 feet. Under these circumstances, the insufficiency of such an entrance for an oceanic canal like that of which we are treating, may be easily comprehended; a canal which should admit ships of the greatest tonnage, and demanding at the least a draft of 23 feet of water. Doubtlessly it would not be impossible to remedy, at least temporarily, this defect; but the uncertainty, proved by experience, of the results of operations carried on at the mouths of rivers even larger than the Chagres, especially when they are for the purpose of opposing the accumulation of sand, should induce us to employ such means only in case it should be impossible to find another suitable entrance; here, however, nature herself appears to have provided one. Five miles to the eastward of the Rio Chagres, is the large and capacious bay of Limon, 2½ miles in width, and 3¾ miles long. It has a great depth of water, which, in the centre, reaches 32 feet. This bay is separated from the river by a tract of land in general of but slight elevation, and offering some low portions, which afford facilities for excavating a canal of communication with the river; works simple and easily constructed, will suffice for the establishment of a vast and sure port at the entrance of the canal, in the bay, which, opening to the north, is at present exposed directly to the action of the north, north-east, and north-west winds, which reign almost constantly in these latitudes.

These disadvantages found at the embouchure of Rio Chagres in the Atlantic, are still more apparent at that of the Rio Caimito in the Pacific. This embouchure is situated in the middle of a vast beach, which low water leaves uncovered; it thus unites a want of depth of water and the inconvenience of sand banks. The coast does not offer in this neighbourhood a favourable locality for a good port, with a sufficient depth of water, for to the depth of water necessary for vessels must be added the height of the tide. But, fortunately, the neighbourhood of the port of Taboga, and the almost constant tranquility of the Gulf of Panama, at the bottom of which is the mouth of the Caimito, permit us, in establishing the entrance of the canal, to take into consideration only the depth of water at high tide.

The place on the coast which appears to me the best to correspond with the required conditions in this respect, is a little bay with an opening of 382 yards, situated 2½ miles to the eastward of the mouth of the Caimito. At its entrance the mean depth was found to be at least 26¼ feet at high tide. There would be but little to do at this point to establish the entrance lock of the canal with such a depth of water that ships might enter, at least at high water, during the neap tides, about the first and last quarters of the moon.

TANNED CANVAS.

Communications from Mr. Hamlet Millett *respecting a mode of rendering Canvas durable by means of Tan, to the Commissioners on the Fine Arts.*

It may be necessary first to state that the process of tanning canvas, although easy and expeditious, is altogether different from that which is employed by tanners for converting the skins and hides of animals into leather: it varies also from that mode in common use among the Yarmouth herring-fishermen and others for tanning their nets to protect them from premature rottenness, although the process of extracting the tan from the oak bark is nearly the same as that which is used by the fishermen for the above purpose, namely, by decoction. It will be seen from the following statement that every possible care and attention has been paid to render the results of the experiments as decisive as could be desired.

Four unprimed ¾ canvases were tacked with copper nails to four stretching frames. The four canvases were cut from off the same roll of cloth, and the stretchers were all manufactured from the same plank of wood. Two of the four canvases, after being stretched on their frames, were immersed for three days and nights in a vat of strong tan, made expressly for the occasion; the tanning liquor being kept, during the whole process, at a temperature of 150°. The two canvases, after being taken from the vat and well dried in the open air, were hung on the side of an underground cellar, the walls of which were never free from damp; the floor was often flooded in wet seasons for months together, and the water, long before it disappeared, never failed to become putrid. This circumstance rendered the situation in which the tanned canvases were hung for trial peculiarly well adapted for ascertaining the power of the antiseptic properties of tan. The two untanned canvases, after being tacked with copper nails to their stretchers, were hung up near the two tanned ones. Care being taken to exclude all circulation of air, the cellar door was locked, and the four canvases were entombed without once seeing the light for no less a period than ten years.

Mr. Millett proceeds to state that when, after the trial, the four canvases were removed from the cellar into the light for examination, the two tanned canvases were found to have completely resisted putrefaction, no symptom of decomposition appearing in any part of them. Pliers were forcibly applied to the edges, but the cloths were found to be as strong as they were on the day when they were first placed in the cellar. The stretchers also, which were tanned with the canvases, were found to be no less sound; they were pierced with a gimlet in several parts, both back and front, and were found to have undergone no change. Not so with the untanned canvases and their stretchers; in them decomposition had made very considerable progress; they were found to be in a half state of decay. On using the pliers the canvas proved to be extremely tender, rending with little exertion. The stretchers also were in a state of decay; on piercing them with a gimlet they were observed to be very unsound; and the growth of fungi, one of the evidences of decomposition, showed itself, particularly about the joints of the stretchers. The same two tanned canvases were again placed in the cellar, together with one of the two untanned canvases; the other, after having been cleansed (as well as its stretcher) from the mould that covered it, I caused to be tanned precisely in the same way in which the other canvases had been treated. After being taken from the vat and dried in the open air, this canvas was also placed in the cellar with the other three, and the door was again closed on them.

These experiments, Mr. Millett adds, were continued with the same canvases during a considerable lapse of time, in all about twenty years. When finally examined, the two tanned canvasses, together, with their stretchers, continued, notwithstanding the severe trial they had experienced, sound in every part; not the smallest symptom of decay could be discovered; proving, far beyond my anticipations, that the antiseptic properties of tan are sufficiently potent to resist putrefaction and decomposition in canvas, and even in wood; hence, rendering them durable even when placed in the most trying situations.

The untanned canvas and its stretching-frame were found, on their final inspection, to be completely decomposed; the canvas dropped from the frame, and the frame itself was a mass of touchwood. The half decomposed canvas and stretcher which I had caused to be tanned before the second trial took place, as above stated, had suffered no further decomposition; a strong proof that tan has not only the power to prevent but to arrest the progress of decomposition. This latter experiment was expressly on a supposition that, if the result should prove successful, the process might be rendered available in prolonging the existence of the valuable works of the old masters.

Process for extracting tan from oak bark for tanning canvas.—One hundred weight of good, sound, and coarsely-ground oak bark, will make one hundred gallons of proper tanning liquor, which is sufficient to tan about sixty square yards of canvas.

To make a vat of tan of any required size.—Take any quantity of good coarsely-ground oak bark, according to the number of square yards of canvas about to be tanned, and water agreeably to the foregoing proportions; boil them together for twelve successive hours in a copper vessel (not in an iron one, as the oxide of iron has a tendency to decompose tan), taking care to supply the decoction with fresh water from time to time to make up the loss occasioned by evaporation. When sufficiently boiled, strain off the tanning liquor from the bark through a hair-sieve, and put it by for use. The tanning liquor thus made is at least three times as strong as that made made use of by the herring fishermen, to render their nets durable, and still stronger than that employed by the Dutch shipowners for tanning the sails of their vessels with the same view.

The copper in which the oak bark has been boiled, will serve every required purpose as a vat, with one trifling addition, namely, a small piece of flat oak board, about nine inches in diameter, and one inch thick, cut into a circular shape, to be placed at the bottom of the inside of the copper. Its use is to prevent the canvas, whilst undergoing the process of tanning, from touching the bottom of the vessel.

Process for tanning the canvas.—Take any quantity of canvas, say 15 yards, to tan which 25 gallons of tanning liquor, made as above are required. Pour the tanning liquor into your vat or copper, and heat it by means of a gentle fire under it, to the temperature of 150°, then immerse the canvas therein, and continue the immersion at the same degree of temperature, day and night, for 48 hours. A longer period would do the canvas no harm; a shorter is by no means recommended. The canvas during the process of the tanning should now and then be moved in the vat, in order that every part of it may be equally tanned. The tanned canvas, on being taken from the vat, must be neither wrung nor squeezed, but hung up or laid out on a grass-plot to dry, allowing the air alone to take up the remaining moisture.

The process for tanning canvas, when strained on stretching frames, is dissimilar to the foregoing, both as to the construction of the vat, and the mode for regulating and keeping up the necessary temperature required for carrying on the process of tanning the canvas already strained. The process about to be described might indeed be dispensed with, as canvas can be as readily strained on the stretching-frames after as before it has undergone the process of tanning, and much labour and expense would be saved thereby; but it has been thought that the stretching-frames on which the canvas is strained, ought to receive from the tan the same protecting advantages as the canvas itself, they being equally subject to the causes of decomposition. Stretching-frames intended to undergo the tanning process, ought to be completely made and fitted, but not put together before they undergo the process of tanning. It is scarcely necessary to observe that the stretching-frames here mentioned are those to which canvas is not yet attached.

To construct a vat for tanning canvas when stretched on its frame, together with the apparatus for heating the tanning liquor, and keeping it at a proper temperature during the operation of tanning.—A case made of oak planking, about an inch in thickness, and somewhat resembling a picture packing-case, was provided, with one side left open to admit the strained canvases; this served as a vat. The case or vat being placed edgewise, a lead worm of a 20-gallon still was wound round the inside of it, and steam from water, constantly kept in a boiling state in the still, and forced through the worm in the vat, kept the tanning liquor at a proper temperature. This was the sort of vat which was used for tanning the two ¾ canvases and their stretching frames, before mentioned; it was expressly made for carrying into effect those experiments.

Mr. Millett proceeds to offer some observations *on the mode of lining pictures*:—A picture requiring to be new lined, being spread out for that purpose, take a basin of strong tanning liquor, prepared according to the foregoing process, and in a moderately warm state; wash the back of the picture therewith, using a soft sponge; when the tanning liquor so applied shall have become dry, the same process should be repeated, and so continued for three or four times. The use of the tanning liquor so employed, is to arrest, by the antiseptic properties of tan, the further progress of the decomposition which may have taken place in the original canvas on which the picture is painted. The second precaution to be observed is to apply a well-tanned canvas as a lining to the picture; and lastly, as a still further protection to it, it would be well to use a stretching-frame that has undergone the process of tanning also.

A vat or apparatus constructed as follows, will be found well adapted for the purpose of tanning stretching-frames:—A square trough of any required length, and about a foot in height and breadth, formed of zinc and lined inside with oak planking, with a lid made to open and shut, is all that is necessary as regards the vat itself. To heat the tanning liquor therein and keep it at a proper temperature, during the operation of tanning, a lead-pipe leading from a steam-boiler, and passing through the tanning liquor in the vat, is also required. The heating process should be regularly kept up for at least 48 hours. The stretching-frames should be regularly made and fitted previously to their being tanned, and they should be tanned before they are finally put together.

The writer further remarks that few things are so destructive to canvas as oil, and expresses his opinion that, in priming canvas for painting, care should be taken to have it well sized, so that it may fully resist the oil in the priming colour.

BRITISH ASSOCIATION.

Session 16*th*, *held at Southampton, September*, 1846.

(*Continued from page* 308.)

Section A.—Mathematics.

Self-Registering Instruments.

Mr. Brooke stated that he had applied to the barometer, thermometer, and psychrometer, a new apparatus, by which also he had obtained a register of variations of the declination magnet, a description of which he had transmitted to the Royal Society. This may be briefly explained to consist of two concentric glass cylinders, which enclose between them a piece of photographic paper, and are carried round by clockwork once in twelve hours. These are covered by a blackened case having a narrow slit parallel to the axis of the cylinders, through which a small point of light, reflected from a spherical concave mirror attached to the magnet, and then refracted through a cylindrical lens, passes and impresses the paper. Some photographs were exhibited, and were much approved of by the president, by Dr. Whewell, and other leading members of the committee who were present: from these the position of the magnet at any given time might generally be determined within ten seconds, and frequently within five. The self-registering barometer was described as a syphon barometer, the extremities of which were nearly an inch in diameter, and exactly the same size, being adjacent portions of the same tube. A glass bulb having a tubular stem rests on the surface of the mercury in the lower end of the tube, and is maintained in a vertical position by small friction-rollers. On this stem rests the short arm of a balanced lever, and the barometer is so placed that the long arm of the lever carries a black paper screen between a lamp and the slit in the apparatus above described; the light of the lamp being condensed by a cylindrical lens placed in front of and parallel to the slit in the apparatus. This screen has a narrow slit in it, at right angles to the former; and the small portion of light, transmitted through the point at which the two slits cross each other, produces a trace upon the photographic paper. The ratio of the arms of the lever may be determined at pleasure, so as to magnify the variations from two to ten times; and as the line is very sharply defined, when magnified five times the variations may be readily determined to the thousandth part of an inch. The author stated that he had not had the opportunity of determining the errors of the instrument, arising from friction and other causes, but he believed them to be very small. In the self-registering thermometer and psychrometer the mercury in a wide flat bore of the tube intercepts a portion of the focal line of light formed by refraction through a cylindrical lens placed as above. This does not require more particular description, as it differs only in details from similar apparatus, of which a description is in print.

Mr. F. Ronalds, on presenting his third annual volume of observations and experiments made at the Kew Observatory, described his experiments on the photographic self-registration of the electrometer, the barometer, the thermometer, and the declination magnetometer, explained his existing apparatus for these purposes, and exhibited the resulting photographs—but first briefly adverted to his previous proposals in 1840 and 1841, and experiments in 1844 relative to the subject. The principal characteristic of his improved system is a peculiar adaptation of the lucernal microscope. An instrument of this kind was employed in July 1845 to register the variations of Volta's atmospheric electrometer. The pair of straws were properly insulated and suspended within the body of the microscope, and towards its object end. A condensing lens was placed at the end itself, and a good lamp stood beyond it; a strong light was therefore projected upon those sides of the straws which were turned towards the condensing lens, and the other sides were in deep shade. The light also impinged upon a little screen fitted into the back of a case about two feet long fixed to the eye end of the microscope, at right angles with it, and vertically; through this screen was cut a very narrow curved slit, whose chord was horizontal, and radius equal to the length of the straws. Between the electrometer and the screen an excellent combination of achrometer lenses by Ross was accurately adjusted, to produce a good chemical focus of the electrometer at a distance as much beyond the external surface of the screen as the thickness of one of the plates of glass to be presently mentioned. In the long vertical case was suspended a frame about half the length of the case, provided with a rabbet, into which two pieces of plate glass could be dropped, and these brought into close contact by means of six little bolts and nuts. The frame could be removed at pleasure from the line by which it was suspended, and the line, after passing through a small hole stopped with grease at the top of the long case, was attached to a pulley about four inches in diameter, on the hour arbor of a clock. Lastly, counterpoises, rollers, and springs were used for insuring accurate sliding of the frame, &c. A piece of photographic paper was now placed between the two plates of glass in the movable frame, the long case was closed so as to prevent the possibility of daylight entering it, the clock was started, and the time of starting was noted. All that part of the paper which was made to pass over the slit in the screen by the motion of the clock, became now therefore successively exposed to a strong light, and was consequently brought into a state which fitted it to receive a dark colour on being again washed with the usual solution, excepting those small portions upon which dark images of the lower parts of the straws were projected through the slit; these parts of course retained the light colour, and formed long curved lines or bands, whose distances from each other at any given part of the photograph, *i. e.* at any given time, indicated the electric tension of that time. Sometimes daylight was used instead of the light from a lamp, and in that case, during the process some appearances of the sky were occasionally noted, by which it was evident that in serene weather, when the sun's light and heat varied, and the paper became consequently either more or less darkened, the electric tension as shown in the photograph varied also, increasing with the increase of light, &c. This fact has not perhaps before been observed; but as the darkening effect on the paper could not always be depended upon, separate notes were taken of the intensities of light and the same results obtained. At the suggestion of the astronomer royal a distinguishing electrometer formed on the day pile system was afterwards employed, which exhibited in the photograph not only the tension but the kind of electricity possessed by the electrometer at any given time.

The *dry thermometer* was next tried; it was of the horizontal kind, had a flat bore, and its tube was introduced through the side of the microscope; the tube had a diaphram of very narrow aperture fixed upon it, and the slit in the screen at the eye end of the microscope was now of course straight and horizontal. The image was a little magnified, and the breadth of the dark band or line in the photograph became the measure of temperature inversely at any time.* The barometer employed was of the syphon kind; the microscope was turned, in order to bring the long case and its sliding frame into an horizontal position; the clock was placed at one end, and a little weight sufficient to keep the frame steady was suspended by a line passing over a pulley at the other end. The lower leg of the barometer was introduced through the now bottom of the microscope, it was provided with a similar kind of diaphram to that on the thermometer, and of course the slit in the screen was now vertical. A very light blackened pith-ball rested on the surface of the mercury, and its image was slightly magnified, but will in future be much more so. The *declination magnet* was one of two feet, provided with a damper, and its mode of suspension was essentially similar to that of the Greenwich declinometer. In order to adapt it for self-registration, a very light conical brass tube, projecting six inches beyond its north end, was affixed to the lower side of the spur which carried it, and to the north end of that tube a small wire, called the index, was attached at right angles; this index descended through little slits in the bottoms of the two cases, enclosed the magnet, &c., and took the place of the electrometer described above in the lucernal miscroscope, which was placed below the cases, and was now required to be much longer than before, in order that the image and motion might be sufficiently magnified, yet retaining a flat field. Everything was very firmly fixed upon the two pillars which formerly carried the transit instrument of George III.

A great many photographs were obtained and sent for inspection to Greenwich. Of some termday impressions, Mr. Glaisher, the magnetical and meteorological superintendent of the Greenwich Observatory, says, in an official note, that "the beautiful agreement of those results with these at Greenwich is highly satisfactory." This must be gratifying to Mr. Ronalds, who has from the first so ably devised and conducted the experiments and observations at Kew.

Mr. Dollond's *atmospheric recorder* registers simultaneously and continuously on the same sheet of paper every variety of change in the barometer, thermometer, hygrometer, electrometer, pluviometer, and evaporator: it also records the force and direction of the wind.

The *barometer* is upon the siphon principle, of a large bore. Upon the surface of the mercury in the shortest leg is placed a float, very accurately counterpoised, leaving only sufficient weight to compel it to follow the mercury, and is correctly adjusted to that part of the apparatus which moves the indicator, when the pressure of the atmosphere is at thirty inches. The connexion of the float with the indicator is so arranged as to give a scale of three to one.

The *thermometrical* arrangement consists of ten mercurial thermometers of a peculiar form. These are suspended upon an extremely delicate and accurate balance. They are placed at the north end of the frame, and are screened from the effects of the wind and rain by perforated plates of zinc.

The *hygrometer* consists of a slip of mahogany cut across the grain. This was placed in a cylinder filled with water, and suspended from the upper end with a weight of two pounds at the other end, until it was found by repeated examination to be completely saturated, and no longer to increase in length. The length was then referred to an accurate scale, and the slip of mahogany placed alongside the pipe of a stove, under the same suspension and weight, until its shortest length was obtained. The difference of the two results being carefully taken, the scale was formed accordingly. It is placed in a tube, open at both ends for a free passage of air, outside the observatory. It is suspended and weighted as before, with full power to act upon the arm of the indicator, quite free from the action of the sun or rain, and is found to be extremely active and firm in its operation, showing upon an open scale every hundredth of its extremes in dryness and moisture.

The *electrometer* for thunder-storms and electric changes is constructed by placing a well insulated conductor upon the highest convenient place, from which a wire is brought down to an insulation on the top of the observatory, and from thence to a standard through another insulation to a metal disc, between which and another fixed disc there is a movable disc attached

* In order to convert this into the wet-bulb 'hygrometer' nothing of course is necessary but the application of the usual cup of water and the capillary threads.

to a glass or insulating arm, for the purpose of connecting it with an accurate support upon which it can move with the greatest facility. In connexion with this arm and disc there is a pencil carried forward to the line of indication. The third disc before stated is fixed to a standard at about three inches from the first: to this a wire is attached and carried into the earth. By this arrangement the electricity put in motion by a thunder-cloud is received and registered. The effect during a thunder-storm is extremely interesting. When a cloud charged with the electric fluid comes within the range of the conductor, the movable disc begins slowly to pass from the first to the third disc, discharging each time a proportion of the electricity, and increasing in rapidity of motion until the discharge of the cloud by lightning takes place. It then falls back to the first disc, and remains perfectly quiet until the next electric cloud approaches. If, in the interim, a cloud charged with rain only should descend or pass over, no movement of the disc takes place.

For the pluviometer, at a distance from the outside of the observatory, there is a receiver of one foot square, clear from all surrounding matter that might interfere with the direct fall of the rain upon its surface. From this receiver a pipe conducts the rain into another receiver inside the observatory, directly under the registering apparatus; in this there is an air-float connected with a set of inclined planes, each inclined plane being equal to one inch of rain. These inclined planes, as they pass up, move the indicator across the destined proportion of the paper; showing, as it proceeds, the result of each drop to the hundredth part of an inch in superficies, and continues to advance until it arrives at one inch. It is then instantly discharged, and returns to the zero of the scale, or commencement of another inch. The internal receiver is calculated to contain six inches of rain.

The evaporator is supplied with water from a vessel which is, in form, an open cube of one foot square, placed by the side of the receiver for rain, and filled from a correct gauge to a given number of inches; it is covered with a plate of glass, elevated sufficiently above the edge of the vessel to prevent rain from falling into it, but not so close as to prevent the air from freely acting upon the surface of the water. A receiver inside the observatory is placed under the arm of the indicator upon the same level as that outside, connected by a pipe. In this receiver there is a float, governed by the evaporation from the external vessel, which moves the pencil of indication until an inch of the water has evaporated; it then, as in the rain-gauge, returns to the zero. This is repeated for several inches until the receivers are nearly empty, when they must be refilled from the external vessel.

The power or force of the wind is registered by a combination of suspended weights, acted upon by inclined planes or edges in connexion with a board of one foot square to receive the impression; this board is kept in opposition to the direction of the wind by a powerful vane, its motion being as free from friction as possible, every part being correctly counterpoised. When the board is acted upon by the wind, it raises the suspended weights by a chain passing over a pulley in a line with the direction of the wind, and well secured from the weather. The suspended weights in connexion with an inclined lever carries the pencil of indication along the scale, and registers the weight lifted in oz. and lb. avoirdupois. The scale having been found, by repeated trials, to be correctly equal to the weights recorded upon it. The direction of the wind is also registered at the same time by another pencil, which marks the course upon the paper, throughout the whole circle of the horizon, or that proportion through which it passes.

Section B.—Chemistry and Mineralogy.

"*On the Decomposition of Water into its constituent Gases by Heat.*" by W. R. Grove.—Prof. Grove, in the first place, called attention to the fact, proved by Cavendish and the French philosophers, that oxygen and hydrogen being exposed to a high temperature, or the electric spark, immediately combined to form water. He then announced his discovery that all the processes by which water may be formed are capable of decomposing water. He believed that the explosion of the mixed gases by the electric spark was due only to the heat of the spark, and not at all to electrolysis. Priestley's method for decomposing gases by passing them through heated tubes was described, and the advantages of using a form of Volta's eudiometer, in which incandescent platina was employed, to effect decomposition, pointed out. By an apparatus of this kind, ammonia, camphor, the prot- and per- oxides of nitrogen were readily decomposed. It was stated that hydrogen gas exposed to the ignited wire always shows the presence of oxygen; and that it is impossible to pass hydrogen gas through water without its taking up so much oxygen, as to acquire the power of giving luminosity to phosphorus in the dark. It was found that if hydrogen and carbonic acid were exposed to the action of the ignited wire, there was a contraction of one volume, leaving a residue of carbonic oxide. If, instead of carbonic acid, carbonic oxide was employed, the mixed gases expanded in volume; and the carbonic oxide, taking oxygen from the water, was converted into carbonic acid. Here we have two dissimilar results produced by the same cause—by means of hydrogen we take oxygen from carbonic acid, and by means of hydrogen we take oxygen from water. If steam is formed in the eudiometric tube and acted on by the ignited wire on cooling, a small bubble of gas is formed, which is found to be oxygen and hydrogen in the exact proportions in which they form water. This is the result of the first action of the heated wire:—in a few seconds a small bubble of gas is formed, but if the action be continued for a week, it does not increase in quantity. It is, however, easy to remove the bubble as it is formed, and bring a fresh quantity of steam under the influence of the heated wire, and thus collect a quantity of gas which should be quite sufficient for any eudiometric examination. Numerous forms of apparatus were described by which this experiment can be performed. It might be objected that, as the wire was ignited by a voltaic battery, the decomposition was not due to the heat of the wire, but to an electrolytic action. This objection would not, however, be maintained by those who were acquainted with electrical phenomena. With the view, however, of removing all doubt, the use of the battery was entirely done away with, and all the results were obtained by the agency of heat alone, in the following manner. Into a silver tube a capillary tube of platina is soldered, and this is again connected with a bent tube, which admits of the removal of any gas formed. The tubes being filled with distilled water, their ends being immersed in vessels of oil or water, the flame of a spirit lamp, urged by the blow-pipe, is brought to bear upon the capillary tube of platina, by which it is almost immediately brought to a white heat. The water is, of course, instantly converted into steam; and this steam is decomposed by the agency of the heat alone. By boiling, we thus convert steam into mixed oxygen and hydrogen gases; and this operation may be continued for any length of time by removing the bubble of gas formed, and bringing a fresh supply of steam under the influence of the heated platina. If fused globules of platina are dropped into water, there is immediately formed a bubble of oxy-hydrogen gas, which may be collected in an inverted tube. Prof. Grove went on to show the probable connexion between this phenomenon of decomposition and the spheroidal state of fluids when they are projected on capsules of heated platina, which had been referred to a repulsive action of a coating of steam enveloping the spheroid of fluid; but in all probability the revolving drop was undergoing decomposition by the agency of the heat to which it was exposed.

Dr. L. Playfair remarked that the facts which Mr. Grove had announced might possibly be regarded as due to a catalytic action of the platina, such as had been observed by Dr. Faraday, and such as was evidenced in the action of oxide of copper on the hypochlorites. Many bodies at high temperatures exhibited a great affinity for oxygen, which they did not possess at lower temperatures, as, for instance, silver, gold, and even platina itself, which metals absorbed oxygen when intensely heated, and gave it out again on cooling. If the experiments had been tried in tubes of quartz or silica, they would not have been open to the objection which the use of so peculiar a metal as platina appeared to involve.

Dr. Leeson made some remarks, which went to show that in all probability the bursting of steam boilers might be explained by the discovery of Prof. Grove.

Mr. Hunt explained some experiments of Woolfe on the boilers of some Cornish steam-engines, which appeared to prove the conversion of steam into gas under the influence of the heat to which the water and steam were exposed in the experiments.

Prof. Faraday thought Mr. Grove's discovery would not explain the bursting of steam boilers, which might be easily done by Prof. Boutigny's experiments on the spheroidal condition of fluids. He did not agree with Prof. Grove that the repulsion of the steam was insufficient to explain the spheroidal state. He would rather desire, in the present stage of the inquiry, to discuss the philosophy of the question than the applications of Mr. Grove's discovery. Was it a decomposition of water by the agency of heat, or was it the action of certain substances when heated? It appeared to him that the investigation was a great step onwards and towards a knowledge of the corpuscular action of bodies, and he did not doubt that some remarkable developments as to the influence of caloric in overcoming the force of aggregation would ensue.

On the changes which mercury suffers in glass vessels hermetically sealed.

Prof. Oersted read a paper on this subject. He said that the progress of these changes is so exceedingly slow, that it seldom becomes sensible for years. He had observed them twenty years ago in a glass bulb of mercury. At first a yellow powder was formed in the bulb, and after some years a black one. He took up the subject in 1838, experimenting with four bulbs, two of white and two of green glass, carefully weighed, in order to detect any portion of air that may be admitted through the pores or fissures of the glass. The weight, however, remained unaltered. In July 1839, a small change was visible. At first a feeble ring of yellow powder adhering to the glass was observed, where the mercury had been a long time in contact with the glass. And again in a new place, under similar circumstances, a new ring was formed, and so on. The surface itself upon which the mercury had rested some time had a thin covering of yellow adherent powder. In the course of years the yellow powder became black. The mercury had lost a great deal of its fluidity, and it adhered slightly to the glass. The order in which the two colours follow each other indicate that they are not produced by oxidation. In the green bulbs no change was visible. In 1845, Prof. Oersted procured twelve bulbs, six of which should contain besides the mercury, atmospheric air, the air of the other six being expelled by boiling the mercury; three of each series being white, and three green glass. In July last there was no sensible change in the first series (namely, mercury mixed with air), but in the second (from which the air had been expelled), change had taken place at all but one. Rarefaction of the air had no connexion with the phenomena, but the boiling of the mercury seemed to have some influence upon them. The Professor intends to continue the investigation of these phenomena, which, however, appear to him to depend upon a reaction between the glass and the mercury. Analysing the two powders, sulphur was detected. But as a yellow compound of mercury and sulphur contains oxygen, and as no oxygen was found in the black powder, it may be questioned whether the first compound takes oxygen from the air of the bulb and returns it in passing to the state of the black one, or that some hitherto unknown exchange takes place between the elements of the glass and the mercury.

"*On the Corrosion of Iron Rails in and out of use.*" By R. Mallett.—The researches on this subject are still in progress, experiments are being made upon six different lines of railway. The principal facts already ascertained are:—1st. That there is a real difference in the rate of corrosion between the rails in use and out of use:—that this appears to be connected with their peculiar molecular condition so induced. 2nd. The determination of the complex conditions as to magnetism, which affect rails some time in use, producing both induced and permanent magnetism in the rails, each rail being magnetic with polarity, and having from four to eight separate poles each.

Mr. Hunt stated his confirmation of the experiments of Ritter—that magnetism had the power of protecting iron from corrosion;—to which he referred the protecting influence exerted on the rails in use on railways.

"*Notice of a Gas Furnace for Organic Analysis.*" By Dr. Percy.—This was an ingenious arrangement, by which gas, burnt, mixed with air, through wire gauze, was substituted for charcoal. Its advantages are its extreme cleanliness, and the power which the operator possesses of regulating, at will, the heat,—which is not practicable in the ordinary furnace for organic analysis with charcoal.

Section C.—Geology.

"*On the Northwich Salt-Field,*" by G. W. Ormerod.—The rock-salt of Northwich is part of the New Red Sandstone series: it forms two strata, the uppermost of which is 75 feet thick, and the lower 105 feet; they are separated by 30 feet of stone, containing veins of salt. Throughout the district, the brine is reached at the same level, about 87 feet below the river Weaver; and varies uniformly in all the shafts when any change takes place. In this district there are three faults, which have displaced the strata to a considerable amount. The first fault is a throw-down to the east of 400 yards; it intersects the South Lancashire coal-field, and passes into Cheshire, along the valley to the west of Bellefield and Hill Cliff, a range of New Red Sandstone (*bunter sandstein*), capped by the ripple-marked beds denominated "water-stones," in which the foot-marks of the *Cheirotherium* occur; the summit is 352 feet above the level of the sea. Near Northwich this fault appears to pass into another, which is an *upthrow* to the east of 460 feet, and passes also through the South Lancashire coal field, by Wigan Churd, and east of Warrington into Cheshire, when it continues along the valley east of the Bellefield range. Through the coal district this line is proved by numerous workings; and in the salt district, by the extent to which the workings and the sinking of the land have gone. The third great fault, passing by Northwich, ranges by south-west to north-east, passing near Holt, and running up the valley between the Peckforton Hills and the low range occupying the east side of the Dee. This valley is occupied by marl, in which saline springs are frequent. At Northwich the line runs in a north-easterly direction, forming the north-west boundary of the rock-salt. The subsidences already mentioned as taking place in the salt district are either sudden or gradual, and have been noticed for many years. At the yard of the Weaver Navigation Office the sinking is at least six feet; and on the road from that place to Winnington the depressions are shown by cracks in houses and visible subsidences in the land. From the same cause, a lock and a factory have required to be removed, meadows are laid under water, and the towing-path by the river has had to be raised. The Whitton Brook has also been made six feet deeper, to enable the navigation to proceed as formerly.

Mr. Phillips observed, that one of these faults laid down in Mr. Ormerod's map was 50 miles long, and one was in the direction of the magnetic meridian. In the south of England, the New Red Sandstone became much thinner, less complicated, and was deficient in salt.

Sir H. De La Beche stated that the variegated tints of the water-stones were due to a difference in the amount of oxydation of the ores they contained. The decomposition of vegetable matter had, in some places, reduced the per-oxide to the condition, comparatively, of a prot-oxide,—changing the red colour of the rock to a pale blue.

Mr. Greenough remarked, that salt existed below the coal-measures in Durham, as well as in the New Red Sandstone, whilst the salt beds at the base of the Carpathians were of tertiary age.

"*On certain Deviations of the Plumb-line from its Mean Direction, as observed in the neighbourhood of Shanklin Down, in the Isle of Wight, during the progress of the Ordnance Survey,*" by Mr. W. Hopkins.—The difference of latitude between Greenwich and the station of the Ordnance surveyors at Dunnose, on the *north* side of Shanklin Down, as determined by triangulation, was *greater* by 2·22 seconds, than as determined by zenith sector observations. When, however, a new station was chosen on the *south* side of Shanklin Down, the difference of latitude, as determined by triangulation, was *less* by 3·99 seconds than it appeared to be when determined by the zenith sector. These discrepancies would be accounted for, if the mass intervening between the stations at Shanklin Down were sufficient to produce, by its attraction on the plumb-line, the observed deviations. The requisite calculations for proving the adequacy of this cause had not been made; the tendency, however, would necessarily be to produce effects of the same nature as those observed; and the author thought it probable that the intensity of the attraction of the hill would be found sufficient to account for the phenomena.

Coal of India.

Mr. Ansted read an analysis of a report to the Indian Government on the coal of India.—The subject of coal in reference to our Indian territories has for a long time been looked upon as of great practical importance; and the increase of steam navigation, as well as the proposed introduction of railroads into that country, renders every matter connected with the subject in the highest degree interesting. I have received, since my arrival at Southampton, through the kindness of Colonel Sykes, a copy of a report recently made to the Indian Government, giving an *aperçu* of the information at present obtained concerning the various beds of coal chiefly in Northern India, and I cannot help thinking that an account of the information thus communicated may be generally useful, especially as much of it is new, and a very large proportion of the remainder, although known to those who have been long accumulating matter that bore reference to this subject, is little familiar to the great body even of those most interested in Indian affairs.

The coal-districts of India, as determined in this report, may be considered as five in number,—three of these are in Northern India, and one in Cutch, while the fifth includes the province of Arracan and the coast of the Burman empire near Tennasserim. Of these the Cutch coal is certainly not of the carboniferous epoch, and it appears to be of little importance at present, and unpromising. It has also been described by Captain Grant, in the Transactions of the Geological Society, and therefore I will not now allude to it. I shall endeavour to describe, first, the chief points of importance with reference to the great and continued series of the North Indian coal-fields, and then allude shortly to the prospects of success in the attempt to obtain coal from the coasts of the Bay of Bengal.

The whole district, extending from the neighbourhood of Hoosungabad on the Nerbudda river (lat. 23 n. long. 78 e.), on the left or south bank of the river, and extending in a north-easterly direction for a distance of about 400 miles to Palamon, thence eastward for 250 miles to Burdwan near Calcutta, and running northward for 150 miles to Rajmahal, exhibits, it would appear, at intervals by no means distant, a continually repeated outcrop of rocks, consisting of sandstones and shales, with occasional limestone; while at intervals a number of beds of coal have been recognised, of variable thickness and value, but all appearing to exhibit evidence of the existence there of a great coal-district.

Commencing again on the flanks of the Garrow mountains, near the Burhampooter, and on both banks of that vast river, we find another, or perhaps a continued, outcrop of similar beds also containing coal, and reaching in a north-easterly direction for nearly 400 miles. The intermediate plains, whose breadth between Rajmahal and Jumalpore is about 100 miles, are chiefly alluvial, and thus it is possible that there exists a vast range of carboniferous strata, reaching for upwards of 1000 miles along the flanks of the Himalaya mountains,—the distance from the mountain chain gradually increasing as we advance westward, the mountains tending northwards and the outcrop of the carboniferous bed southwards, until finally, the distance between them being upwards of 500 miles, the relation is not easily recognised. The whole of the drainage of the Ganges and the Burhampooter occurring, however, in this interspace, we are enabled to connect the geological phenomena in a very interesting manner. Before, however, considering the relation of the discovery thus made to Indian geology generally, it will be necessary to give some account of the nature of the coal in the various places where it has been worked, and the present state of our knowledge on the subject.

Neighbourhood of Calcutta.

I. Commencing with the neighbourhood of Calcutta, we have first to consider the Burdwan coal-district, and with this I shall group the Adji and the Rajmahal fields; all these are on the banks of either the Hooghley or Ganges, or on the tributaries of these rivers. The Burdwan district has been long known, and a good deal worked. The workable beds of coal are nine and seven feet thick respectively. They are associated with sandstone, shale, and a little clay, ironstone, and about six other thinner seams of coal, while other thick beds are mentioned, but their real existence as separate beds is doubtful. There are now thirteen spots at which this coal is worked, but most of them are surface working. The deepest sinking is 190 feet. The distance to Calcutta is about 90 miles, but the actual transit of coal is nearly 200 miles. There would seem to be a continuous outcrop of the same kind of rocks from Burdwan up the Adji river, and northwards to Rajmahal. On the Adji river the coal has been worked in more than one spot, and is found to be of about the same quality as that of Burdwan; but neither of them is considered of nearly so good quality as the English coal. Farther on, at Rajmahal, coal is known to exist, but has not yet been much worked. The quality of that which has been obtained does not appear good.

Palamon Coal Field.

II. The Burdwan coal-field appears to be connected, by a continuous outcrop, with a district at Palamon, in which coal has been worked in no fewer than four places. The coal here is apparently immediately reposing in a valley enclosed by hills of granite, and is associated with a good deal of iron. There are several beds that are of workable size, but a good deal of the coal is heavy and of inferior quality, and some of it appears to be anthracitic. These coal-beds are not far from the Soane river, a n about 100 miles from its confluence with the Ganges, a little above Dinapoor and Patna; but the Soane is not at present navigable. To the west of Palamon the carboniferous beds are described as appearing along two irregular lines, the one towards the south-west for 150 miles, reaching beyond Koorbah, and the other more westward, by Sohagepoor, to the Nerbudda. These beds appear to connect themselves with the Burdwan coal-field; and near Ramgurh, coal has been obtained in two or three places. This coal is said to be of very good quality and of considerable thickness; but there can be little doubt that a statement made in the report, of the bed of coal being 200 yards in thickness, must be owing to some misunderstanding of the account and sketch originally communicated. It seems certain, however, from the extent of the outcrop, that the seam must be one of considerable magnitude. Westwards, again, from Palamon, and at a distance of about 50 miles, coal has been found in several places in Singrowli, but the beds at present known are thin; and again, to the south-west, the same mineral occurs at Sirgoojah, where fine coal has been seen, but is not used at present. Between the Singrowli coal and Jubbulpore excellent coal has been found in several places, indicating an extensive coal-field; but the nature and thickness of the beds is not stated.

The Nerbudda district, although from the drainage of the country it belongs to the Bombay side of India, is manifestly more related, so far as the old rocks are concerned, with the Bengal territory. The coal is about 350 miles from Bombay, and the Nerbudda river is at present not navigable. There seem to be three districts in the Nerbudda valley in which coal is found, but the most important of them is that near Gurrawarra, about midway between Hoosungabad and Jubbulpore. The coal here, indeed, appears to be perhaps the best hitherto found in India, and exists in beds three in number, whose thickness respectively is said to be 20 feet, 40 feet, and 25½ feet. There are also other beds, one of which is four feet.

The discovery of this, the Benar coal-field, promises to be of great importance. It is also very near another basin, where there are beds also of excellent quality, one of them 6 feet in thickness. At Jubbulpore itself coal has been found at a depth of 70 feet, one bed being nearly 12 feet thick.

Coal Fields East of Calcutta.

III. Let us consider now the district east of Calcutta. We there find true carboniferous rocks on both flanks of the Garrow Mountains, commencing near Jumelpore, and thence continuing north-eastwards for a distance amounting on the whole to nearly 400 miles through Lower and Upper Assam. The district nearest Calcutta is Silhet, on the south flanks of the Garrow, where eleven beds of coal have been determined, whose total thickness as already ascertained is said to amount to 85 feet. This coal is of excellent quality, and can as readily be conveyed to the Upper Ganges as the Burdwan coal. The most remarkable beds occur at Cherra Ponji; but these appear irregular, although they are undoubtedly of great thickness in several spots, amounting sometimes to nearly 30 feet. There are also other important beds. They have been known for more than ten years, but have not been worked; and since their first discovery large quantities of iron have been smelted with charcoal.

After passing the districts in which the coal has been thus clearly exhibited, we proceed next to the Assam districts, also more or less continuous, and extending for about 350 miles chiefly along the south side of the Burhampooter; the whole being divided into the two groups of Lower and Upper Assam, separated at Bishenath, 170 miles above Calcutta. Six coal-fields are enumerated in the Upper district, and three in the Lower; but the latter, although it would seem not so promising, are looked on as scarcely less important in consequence of their greater accessibility.

So far as details are concerned, however, the Lower Assam coal offers but little that is in any way positive; the indications consisting rather of rolled fragments drifted, than of distinct and well-marked beds. It is called lignite in a report from Lieut. Vetch; but both coal and lignite are terms frequently used without reference to any peculiar character of the mineral, or any geological position. Similar beds of coal or lignite to those found in Lower Assam, south of the Burhampooter, are also mentioned as occurring on the north in three of the streams flowing into that river from the Bootan range. The Upper Assam coal is manifestly of great interest, and likely to prove very important. It is associated with abundance of clay ironstone.

About eighty miles above Bishenath other beds, stated to be 6 feet thick, have been worked for the sake of trying the economic value of the coal. It is described by the commander of one of the Assam Company's steamers, in a letter dated 24th January, 1845, as far the best he ever had on board a steamer, and far superior to any coal in Calcutta. From the growing importance of the tea-trade from Assam, this is likely, therefore, to be of great value. Still farther up the country there are several important beds, dipping, it would appear, at so high an angle, and placed so unfavourably with regard to present means of transport, that it would be difficult to work them. The other beds that appear in this district are exposed to the same difficulty; and the coal throughout northern India appears to be in this respect unfavourably placed.

Passing on now to the other districts in India, and the East, in which carboniferous rocks and beds of coal have been met with, I have to enumerate two, the Tenasserim and the Arracan districts, which, from their near vicinity to India and their geographical position, are of considerable importance. The former has been known for some years, and there are said to be four spots at which coal appears; but of these one only seems likely to prove of economic value. From the accounts given of this coal there is every reason to conclude, that one of the beds is not of the carboniferous period; and although another (on the Thian Khan) has been the subject of a far more favourable report, being called cannel coal, and stated by Mr. Prinsep to be an admirable coal for gas, there is yet much probability of the whole being of the tertiary period. These beds have been described in the *Journal of the Asiatic Society* for 1838.

In Arracan there are eleven beds of coal, but all of them are thin, and their position nearly vertical. They are said to be associated with sandstones, limestones, and shales; but it is clear that they can at present be looked at only as indications, and not of any practical importance.

Such is a general account of the coal-districts of India, so far as I have been able to glean evidence from the report of the committee for the investigation of the coal and mineral resources of India for May 1845. This report manifestly contains much detailed information that is of practical importance; but one can hardly help being struck by the absence of that definite information with regard to associated beds, and the general position of the coal, which could alone, under the peculiar circumstances, have given to geologists satisfactory evidence as to the age of this widely-extended deposit. Speaking now to geologists, and to many who are fully alive to the vast importance of accurate and detailed knowledge of the structure of a country before great mining operations are commenced in it, I need not do more than allude to the absence of this kind of information; but, having stated its absence, I may perhaps be permitted to offer my own views of the subject as obtained from the perusal of the documents laid before me.

Geological Position.

Connecting, as I think we cannot help doing, the general geology of Asia with that of Europe, and looking at the wide extension of true coal-bearing rocks in the northern hemisphere,—tracing these rocks, as we are able to do at intervals, from our own country eastward through Belgium, Northern Germany, Bohemia, and Silesia, thence across to the valley of the Donetz, watching the development of the older beds of the Devonian period in Armenia, and thence on the northern side of the great Himalayan range,—discovering them in their most characteristic form in the Altai mountains, and finding them also on the south flanks of these lofty mountains in the neighbourhood of Calcutta, where the Burdwan beds have long been known, giving satisfactory evidence of their age; there is certainly no reason for wonder if these carboniferous beds, in their most typical and valuable form, should be traceable also throughout Northern India. For what is the geological structure of that country? The Himalayas themselves, the great back-bone of Asia, are probably to be looked on as a mountain chain much more recent than the Alps. In India, the great Sewalik tertiaries, where fossils are now being figured and described by Major Cautley and Dr. Falconer in a monograph, the most magnificent that has yet been attempted, are lifted into hills which elsewhere might well deserve the name of mountains; and whatever the conditions may have been subsequently to original deposition of the beds, there is no reason why, in a country where the scale is in everything so vast, there should not be a continuous outcrop of carboniferous rocks for hundreds of miles together. In consequence of movements of very recent date, wide tracts of India, occupying tens and almost hundreds of thousands of square miles to the south, are covered with basalt, and other large tracts of still greater extent by modern and almost alluvial formations, providing by their decomposition the most prolific soil in the world. Between and amongst this extent of modern eruptive movement, and forming, perhaps, a barrier to some of the beds, comes in, it would seem, the great range of carboniferous beds, exhibited at intervals through the country, nearly parallel with the great range of disturbance, and also greatly disturbed and elevated, and broken into small basins. So far as the evidence goes, it is certainly probable that the coal found near Burdwan to the north and west, and apparently continuous with it, is of the same age. If so, analogy would suggest that the similar and similarly situated beds much farther to the west but still nearly continuous, are of the same age; and the districts to the east contain, it would seem, at least some coal so like the other in quality, that here also we should expect it. But analogy goes yet farther, and running down the coast of the Birman empire towards the great island of Borneo, recent investigations seem to show that there also beds of coal of great value, and of the carboniferous epoch, exist. I will not cross the great line of elevation in the tropic of Capricorn, and cross to the eastern coast of Australia, for a farther illustration; but the idea cannot fail to strike every geologist that so singular an association of similar beds over so large a part of the existing land on the earth must, if true, have its origin in some general cause, the result of a law of far greater universality than any we now recognise.

But, on the other hand, it is by no means impossible, when we consider the extent to which the tertiaries are developed in the great range of conglomerates on the flanks of the Himalayas, and the similar and almost equally fossiliferous deposits on the banks of the Irawaddi on the east and in the Gulf of Cambey on the west, that, after all, these beds are not carboniferous, but merely occasional and irregular bands of modern or tertiary lignite. Should this be the case, it will be necessary and interesting to determine the point, and recognise, if possible, the actual extension of the Burdwan field, concerning whose age the fossils collected by Dr. Royle leave no doubt. The relation also of these beds with those of the Altai, mountains by a comparison of fossils is an important and most interesting point.

Economic Value of the Coal Fields.

Speculations of this nature cannot fail to be suggested by the present communication. A vast and most important subject is presented for our consideration, but, unfortunately, the evidenee is imperfect in a most important point. These beds of coal, occurring as they do chiefly in granitic basins, and often detached, like the coal of France, may be, as I believe they are, of the carboniferous age; they may also be oolitic, like the imperfect coal of Cutch, and of some parts of our own country, or they may be tertiary lignites. Now it may seem of little importance to the mere surveyor what the geological position of these beds may be, provided there is the material he needs; but experience renders it probable that on the mere question of age does, in fact, depend much of their true economic value. Could it be satisfactorily shown that throughout the wide district of northern India there is a true outcrop of carboniferous beds, such as occur in England, in America, or even in eastern Australia, there can be no question that the value of a very large part of the possessions of England in the East might be considered much increased; for the beds would then probably be steady and permanent, and the application of the resources in knowledge and wealth of a great, a rich, and an enterprising people, would very soon bring into operation, in all those districts, manufactures and commerce on the grandest scale. The navigation of the rivers, the state of the roads, the means of communication by railroads, would be immediately established or permanently improved; and the result must be improvement in the condition of the country.

Should it, on the other hand, appear that these so called coal-fields are merely detached basins of lignite, whether tertiary or oolitic, they would, in all probability, be of variable and local thickness: their value might appear considerable at the first glance; but it might even not repay the expense of working: the quantity would be much less than was calculated, the quality would not improve in deep workings, and the real and important uses of mineral fuel would not be recognised in it. A small amount of strict geological knowledge and a few fossils would have tended to set at rest, if it did not completely settle, this question, which I think it will be at once seen is of great importance. I ought, perhaps, to apologise for taking up the time of the meeting by such remarks as these; but the absence generally of distinct knowledge of the principles of our science amongst gentlemen who on every other account are so admirably adapted for the work they undertake is too well illustrated in the present case and too generally important not to excuse my introducing the subject. My own position, too, as one of those employed in the education of a large number of practical men in geological science; and the fact that I have interrupted a course of geological lectures to the cadets, who will in future years form the great body of the officers of our Indian army, is a satisfactory proof that this view is now beginning to be understood by those who are, perhaps, most interested in its application. Much yet remains to be done in the application of science to art, and possibly the result of the present investigation may give additional reason, if any were wanted, for commencing some general system of scientific education.

The result of the present inquiry will be seen at once to be unsatisfactory, although highly suggestive for future investigation. No value can be attached to mere statements of the existence of carbonaceous matter in beds, because many of the important practical conditions are independent of mere appearance and experiments on detached fragments.

Col. Sykes observed that it was of importance to obtain coal for the proposed railways in India, especially as wood was beginning to be scarce in many parts. The report mentioned the occurrence of coal at 90 localities,—most of them in a bed between the Nerbudda and Calcutta. With a trifling exception the whole of India south of this line was destitute of coal.

Mr. Lyell stated that he had lately examined the coal-field of Richmond, in Virginia,—one of the most valuable in the United States. He had obtained fishes from that coal-field, which M. Agassiz referred to the *Oolitic period;* and the plants, which had been examined by Mr. Bunbury, presented an assemblage agreeing with those found at Whitby, in Yorkshire. The coal-field was known to be newer than the carboniferous period; and it contained one bed of coal, 30 feet thick, from which gas had been made,—and it was now becoming of great value. No estimate of the probable value of Indian coal could be formed by comparing it with coal of the same age in Europe.

Sir H. De la Beche observed that it was incorrect to suppose that, in other countries, the most valuable coal would be found in rocks agreeing in age with our own coal-measures. The *Burdwan* coal appeared to be of the same age with the Australian coal, as there were plants common to both.

Mr. Jukes pointed out the identity in direction of the granitic hills of North-Eastern Australia with those of the Malay Peninsula; and the occurrence of coal, at an intermediate point, in Borneo.

Dr. Falconer considered the Burdwan coal-field peculiar:—its plants were all unlike those of Europe; and it contained neither dicoyledonous nor coniferous wood. He thought it might be older than any of our coal-fields.

Mr. W. Sanders exhibited Sections made on the line of the Great Western Railway, between Bristol and Taunton.—The general section represented a distance of 45 miles, on a scale of 33 inches to the mile. It passed first through the junction beds of red marl and lias; then for 6 or 7 miles through new red sandstone, touching once upon the upper beds of the carboniferous limestone. For the next 12 miles there are alluvial tracts, separated by cuttings of new red sandstone. At 21 miles, the Uphill cutting passes through the new red sandstone and lias and then the carboniferous limestone, at the base of which are some masses of trappean rock. The railway then proceeds for 17 miles over an alluvial plain, interrupted only by a cutting through the new red marl and lias at Puriton. From this point to Taunton the course is over a moderately level country of new red sandstone. Four enlarged drawings represented the details of the Ashton, Uphill, and other cuttings. In the section at Pylle, Mr. Sanders discovered remains of Cypris, and a plant (*Naiadites lanceolata*), in the lower lias marls; and in the Uphill and Puriton sections the representatives of the bone bed occurs. Since there are usually several calcareous beds in the lower marls, containing the same fish-scales, shells, &c., Mr. Sanders prefers the classification of Mr. Conybeare, who considered these beds the lowest member of the lias to the separation of the bone bed,—which is only a part of this series, into the Triassic system, as proposed by M. Agassiz, on account of the nature of its fishes.

"*On the Muschet Band, commonly called the Black-band Ironstone of the Coal-field of Scotland.*" By Mr. Bald.—This band of ironstone was discovered about forty years ago, by Mr. David Muschet, of the Calder Iron-works, near Glasgow. It had been frequently passed through; but was thrown away as rubbish till Mr. Muschet ascertained its value,—when extensive mines were opened for working it. Two bands of this ironstone are found in the great coal-fields of Lanark,—one 14 inches thick; the other, which is 73 fathoms lower, is 16 inches thick. The ironstone of the Muschet band is much more easily reducible than the ordinary dry ironstone,—and requires less fuel. In Scotland it appears to be co-extensive with the coal formation. In South Wales, also, it is found; but there is little of it in England or Ireland. Fifty years ago there were only five iron-works in Scotland, comprising about fifteen blast furnaces which, together, produced 540 tons of iron per week. There are now 100 blast furnaces in action, which produce 12,000 tons per week, or 624,000 tons in the year,—the value of which, at 3*l.* per ton, is 1,872,000*l.* This great increase Mr. Bald attributed to the discovery of the Muschet ironstone, and to the introduction of the hot-blast. He also mentioned that Mr. Muschet, who is now in his eighty-sixth year, has published a volume on the manufacture of iron, containing an analysis of every ironstone and ore he could obtain; and he trusted his labours would, at least, be recognized in scientific societies, although the pecuniary advantage arising from his discoveries had fallen into other hands.

Section G—Mechanics.

"*On the Sailing Powers of two Yachts, built on the Wave Principle.*" By Dr. Phipps.—The first was built for Dr. Corrigan, of Dublin, in 1844; a small open boat 24 feet by 6, of 3⅔ tons, which did so well that she was able to beat everything near her own size, and to sail with those which exceed it in some instances as far as four times. She was dry in seas where they were wet, was very stiff, sure in stays, and steered well at all times. The second is a yacht of 45 tons, O.M., for Samuel Hodder, Esq., of Ringabella; built from the drawing by Mr. Peasley, of Passage West, in Cork. She appears to have the following qualities: a first rate performance, attained without sacrifice of any good quality, large accommodation, high stability. She is weatherly, steady and easy, dry in the worst weather, and pitches and ascends less than any vessel I was ever in. She turns so sharply that no 10 ton yacht can do it quicker, and steers so well, scudding in a gale of wind, that notwithstanding an unbalanced state, from an injudicious shift of mast, she neither broaches to, nor is compelled to lay to—which a companion of larger size (60 tons), and of tried sea qualities, was forced to do, and, in consequence, arrived from Cork to Dublin 14 hours after the wave-built yacht. In a race at Kingstown for the Railway Cup of 100 guineas, in which she was matched against the best boats of the three countries, in a time race, including one fine yacht of 100 tons, she won—and did the course exactly in 4h. 22m. 58s.—it being 46 nautic miles. Making no allowance for tacking or starting from absolute rest, the rate of this is 10½ knots per hour. This is a great result for a principle yet in its infancy. The same vessel left Holyhead in a gale of wind, with storm-sails, main-sail stowed, and everything made snug; with a reefed try-sail, a double-reefed fore-sail,, and third jib. She lay in one stretch to the Irish coast, where she tacked to the southward, beating down to the Arklow light in 11 hours. Six persons on board, being separately questioned, agreed that the time from Holyhead to the Irish coast was 4½ hours. Making every reasonable allowance, less than 50 nautic miles could not have been done; and this gives a velocity of 11 nautic miles per hour,—an unrecorded speed for ships of any size, close hauled, but surprising for a vessel of 45 tons, and in a very rough sea. It was, in fact, remarked on board that, as the wind freshened, her pace increased without limit. This agrees with the fact stated by Capt. Fishbourne, of the Flambeau steamer, on wave lines, that she had a speed greatest in the worst weather, as compared with her rival.—It is perhaps possible to improve sailing vessels greatly, as compared with steamers. When so improved, they might be used where sailing vessels nearly compete with steamers at present. This may be further helped by the diminution of insurance and of the present unneccssary waste of human life.

Mr. Scott Russell, after expressing his gratitude to the Association for directing its attention to so important a subject, proceeded to explain the theory of what was known as the wave principle in ship building. He was first induced to direct his attention to this subject when the canal companies proposed some years ago to establish swift boats that might compete with the mail coaches. On being applied to by them, his first attempt was to build one with a spheroidal bow, produced by the revolution of an ellipse; but the result was not as successful as was to be wished. The favourite shape of bow among seamen at the time was that called a duck's breast, but the effect was to raise a large wave immediately in front of the vessel, which of course considerably retarded its velocity. He then directed his attention to the motion of the water itself. When a vessel passed through the water at a great velocity a high wave was raised at the head, as high in the old steamers as four feet; and this wave on falling back formed a hollow by its pressure immediately behind it, and the water was afterwards sent out with great force on both sides of the bow. All this was a costly and useless expenditure of force. He thought that, in removing the particles of water to allow the vessel to pass, it was necessary to expend the least force on the whole; and, therefore, the first impulse should be given gently. This force should increase to a certain point, and then decrease as gradually, leaving the particles to rest quietly at the greatest breadth. In endeavouring to ascertain the least resistance necessary to bring the particles of water out of a state of rest he conceived that there ought to be a similarity between the motion of water and that of a pendulum revolving in a circle according to the curve of the vessel's size; and this led him to adopt the form known as the wave principle. This is different from a bow formed of two straight lines meeting at an acute angle, in being gently hollower than such a bow towards the cut-water, and a little rounder towards the greater breadth. The object to be attained was, he conceived, to remove the particles of water rapidly, and at the same time not to throw them farther aside than the breadth of the vessel amidships. That this object was effected by the wave principle he ascertained in the following manner:—He got his model boat, 75 feet long, to be carried along by high-bred horses at a speed of 17 miles an hour, and made the head pass between two oranges floating on the water, and which he intended to represent two particles of the water to be removed. The oranges merely touched the side of the vessel until they got amidships, and there remained; thus showing that no greater force had been applied to them than was necessary to remove them out of the way of the vessel. Another phenomenon observed was, that, instead of the high wave at the bow, which sailors thought was a sign of a ship sailing well, or what they called carrying a bone in her teeth, the elevation and subsequent depressson of the water were entirely got rid of. In their place there was a gentle, long elevation, just under the shoulder of the vessel, where all sailors would like her to be supported. For the closing of the water at the stern he at first thought it would be better to have the same shape behind; and this had the effect of bringing the oranges together again behind in an horizontal direction; but he found it did not answer at all. It occasioned too high a resistance, and had a multitude of bad qualities. He discovered, in fact, that the fuller she was behind, and the flatter she lay upon the surface of the water, the quicker she sailed: and that this should be the case is clear, when it is considered that the water, returning to its level, is governed by an entirely different law from that by which it is first separated. The power which sends the water into the wake has nothing to do with that which displaces it before. It is forced upwards by the greatest pressure from below in vertical lines of the cycloidal family. A run fine below and full above was attained by many experiments, as the best for good steering and other qualities. This full water-line above should never exceed a cycloid. The vertical lines, in which the water rises in the secondary wave (which really replaces the displaced water) may be cut off, at any convenient height, close to the stern. These two considerations united led him to the adoption of what is known as the wave principle. In the wave formation the greatest breadth of the ship is not at the bows, or even amidships, but a great way aft, in the ratio of three to two. In the shear plan the bow of this form has one main cycloid, and all the other bow lines are parts of cycloids. In this form the particles ascend and descend without shock.

Mr. Vignolles asked if the Admiralty had got vessels built on this principle,—*and if not, why not?*

Mr. Scott Russell replied, that he had been much more desirous for the adoption of the system in other ships than in the Admiralty, because he had been informed that the Admiralty did not like the introduction of scientific principles into ship-building, and preferred remaining as they were. He had, therefore, been averse to obtrude the subject on them. He might state, however, that the best informed men at the Admiralty were aware of the existence of the wave principle; and it was not improbable they might adopt it, although he could not say how soon, nor to what extent.

Professor Owen's Geological Lecture.

Extinct Animals of Great Britain.

In one of the evening lectures the Professor commenced by stating that he proposed to submit to the learned and distinguished assembly which he had the honour of addressing some of the general conclusions which he had deduced from a study of the fossil remains of the class mammalia discovered in the soil of Great Britain; and he deemed it fortunate to have this opportunity of showing what enlarged and unexpected views of ancient nature might be obtained from dry comparisons and descriptions of processes of bone and tubercles of teeth, and he hoped to make those views intelligible to all, without the obscuration of technical anatomical terms. He proposed, first, briefly to notice the principal forms or kinds of mammalian quadrupeds that had been successively introduced into the portion of earth which now constituted our island; secondly, to consider the mode of their introduction here, and their relations to existing species at present localised in Europe and Asia; and, finally, to point out the correspondence between the existing and extinct groups of mammalia peculiar to other great natural divisions of dry land.

Animals Preceding the Oolitic Period.

We discern, he said, the earliest trace of the warm-blooded, air-breathing, viviparous quadrupeds at that remote period which immediately preceded the deposition of the oolitic group of limestones. The massive evidence of the operation of the old ocean, from which those rocks were gradually precipitated, extends across England, from Yorkshire on the north-east, to Dorsetshire on the south-west, with an average breadth of nearly thirty miles; and from some land which formed the southern shore of this arm of sea, were washed down the remains of small insectivorous, and probably marsupial quadrupeds, distinct in genus and species from any now known in the world. With these small mammals there occur elytra of beetles, and debris of cycadeæ and other terrestrial plants. The character of some of these vegetable fossils and of the associated shells, as the trigoniæ, and the great abundance, in the oolitic ocean, of fishes whose nearest living analogue is the cestracion, recall many of the characteristic features of actual organic life in Australia. From the remote period in which the remains of mammals first make their appearance to that in which we again get indubitable evidence of their existence, a lapse of time incalculably vast has occurred. We trace it, though inadequately, by the successive deposition from seas and estuaries of enormous masses of rocks of various kinds, the graveyards of as various extinct forms of animal and vegetable life. The shelly limestone slate, which contains the bones of the amphitheria and phascolotheria, lies at the base of the inferior oolite. Upon it have been accumulated the enormous masses of the great oolite, the cornbrash, and the forest marble; and upon these have been successively piled the Oxford clay and coral rag, the Kimmeridge clay and Portland stone. In the still more enormous masses of Wealden rocks, rising to the height of eight hundred feet, and deposited after the formation of the Portland sands by the water of an immense estuary, no true indications of warm-blooded animals have been hitherto discovered. Four hundred feet deep of gault and greensand rest upon the Wealden, but reveal no trace of cetacean or other form of mammalian life. Over these foundations of the present south-eastern part of our island the ocean continued to roll, but under influences of heat and light favourable to the development of corals and microscopic calcareous shells, during a period of time which has permitted the successive accumulation of layers of these skeletons, in a more or less decomposed state, with probable additions from submarine calcareous and siliceous springs, to the height of one thousand feet. But although amongst the remains of higher organised animals that have become enveloped in the cretaceous deposits there have been recognised birds, pterodactyles, and a land-lizard, probably washed down from some neighbouring shore, no trace of a mammalian quadruped has yet been discovered in them. The surface of the chalk, after it had become consolidated was long exposed to the eroding action of waves and currents. Into deep indentations so formed have been rolled fragments of chalk and flint, with much sand. The perforations of marine animals on that surface have been filled with fine sand; and there are many other proofs of the lapse of a long interval of time between the completion of the chalk deposits of Britain and the commencement of the next or tertiary era. Of this era our present island gives the first indication in traces of mighty rivers, which defiled the fair surface of the rising chalk by pouring over it the debris of the great continent which they drained,—a continent which has again sunk, and probably now lies beneath the Atlantic. The masses of clay and sand that have been thus deposited upon the chalk are accumulated chiefly in two tracts, called the London and Hampshire basins, which seem to have been two estuaries or mouths of the great river; the one extends from Cambridgeshire through Hertfordshire and Suffolk to the North Downs, the other from the South Downs into Dorsetshire.

At the time when these vast but gradual operations were taking place, an arm of sea extended from the north to the area called the basin of Paris, which received the overflow of a chain of lakes extending thither from the highest part of the central mountain-group of France. An enormous mass of mixed or alternating marine and fresh-water deposits was accumulated in this basin, coeval, if we may judge from the identity of the species of shells, with the outpouring of eocene, London, and plastic clays upon the English chalk.

Eocene Animals.

The proofs of the abundant mammalian inhabitants of the eocene continent were first obtained by Cuvier from the fossilised remains in the deposits that fill the enormous excavation in the chalk called the Paris basin. But the forms which that great anatomist restored were all new and strange; specifically, and for the most part generically, distinct from all known existing quadrupeds. Long before any discovery had been made of remains of terrestrial mammals in the contemporary London and plastic clays, the existence of neighbouring dry land had been inferred from the occurrence in those deposits of bones of crocodiles and turtles, and from the immense number of fossil seeds and fruits, resembling those of tropical trees, as pandani, cocoa-nuts, &c.

Scanty as are the eocene mammalia hitherto discovered in the London clay, they are highly interesting from their identity or close affinity with some of the peculiar extinct genera of the Paris basin. In the fresh water and marine beds at the north side of the Isle of Wight, and at the opposite coast of Hampshire, the united thickness of which beds is about 400 feet, remains of the very same peculiar quadrupeds of the contemporaneous Parisian formations have been found.

One of the rarest and most remarkable of the pachyderms, whose peculiar characters were obscurely indicated by Cuvier from scanty fossils yielded by the Montmartre gypsum, has had its claims to generic distinction established, and its nature and affinities fully illustrated, by more perfect specimens from the eocene marls of the Isle of Wight: in no other part of Great Britain has any portion of the chæropotamus been found, except in the above limited locality, which alone corresponds with the formations of the Paris basin in mineral character as well as in date and origin. This discovery becomes, therefore, peculiarly interesting and suggestive. For were the common notion true, that all the fossil remains of quadrupeds not now existing in our island had been brought hither during a single catastrophe, and strewed with the detritus of a general deluge over its surface, what would have been the chance of finding the lower jaw of a chæropotamus in the very spot and in the very limited locality where alone in all England the same kind of deposits existed as those in which the unique upper jaw of a chæropotamus had been found in France? With the chæropotamus are associated, in the Binstead and Seafield quarries, remains of anoplotherium, dichobunes, palæotherium, and lophiodon, showing, with the fossils from the London clay, that the same peculiar generic forms of the class mammalia prevailed during the eocene epoch in England as in France.

With the last layer of the eocene deposits, we lose in this island every trace of the mammalia of that remote period. What length of time elapsed before the foundations of England were again sufficiently settled to serve as the theatre of life to another race of warm-blooded quadrupeds, the imagination strives in vain to form an idea of, commensurate with the evidence of the intervening operations which continental geology teaches to have gradually and successively taken place. Our own island yields us but a dim and confused indication of the geological operations that took place between the eocene and pliocene periods, in the wreck of strata that constitute part of the so-called crag formations on its eastern coast. When the eocene and other foundations of our present island begin to rise from the deep and become the seat of fresh-water lakes, receiving their tranquil deposits, with the abundant shells of their testaceous colonies, and during the long progress of that slow and unequal elevation which converted chains of lakes into river courses, an extensive and varied mammalian fauna ranged the banks or swam the waters of those ancient lakes and rivers: of this we have abundant evidence in the bones and teeth of successive generations which have been accumulated in the undisturbed stratified lacustrine and fluviatile formations. The like evidence is given by the existence of similar remains in unstratified coral drifts, composed of gravel exclusively derived from rocks in the immediate vicinity of such drift, without a single intermixture of any far transported fragment; equally conclusive and more readily appreciable proof that the now extinct pliocene and pleistocene mammalia actually lived and died in the country where their remains occur, has been brought to light from the dark recesses of the caves which served as lurking places for the predaceous species, and as charnel houses to their prey.

Gigantic Pliocene Animals.

At the period indicated by these superficial stratified and unstratified deposits the mastodon had probably disappeared from England, but gigantic elephants of twice the bulk of the largest individuals that now exist in Ceylon and Africa roamed here in herds, if we may judge from the abundance of their remains. Two-horned rhinoceroses, of at least two species, forced their way through the ancient forests or wallowed in the swamps. Deer, as gigantic in proportion to existing species, were the contemporaries of the old uri and bisontes, and may have disputed with them the pasturage of that ancient land. The carnivora, organised to enjoy a life of rapine at the expense of the vegetable-feeders, to restrain their undue increase and abridge the pangs of the maimed and sickly, were duly adjusted in members, size, and ferocity, to the fell task assigned to them in the organic economy. Besides a British tiger, of larger size, and with proportionally lager paws than that of Bengal, there existed a stranger feline animal of equal size, which, from the great length and sharpness of its sabre-shaped canines, was probably the most ferocious and destructive of its peculiarly carnivorous family. Of the smaller felines, we recognise the remains of a leopard or large lynx, and of a wild cat. Troops of savage hyenas, larger than the fierce crocuta of South Africa, which they most resembled, devoured what the nobler beasts of prey had left. A species of bear, surpassing the ursus ferox of the Rocky Mountains, found its hiding place in many of the existing limestone caverns of England. With it was associated a somewhat smaller kind, more like the common European bear, but larger than the present individuals of the ursus arctos. Wolves and foxes, the badger, the otter, the foumart, and the stoat, complete the category of the known pliocene carnivora of Britain.

These animals native in Great Britain.

The first idea which commonly suggests itself on the discovery at some depth in the soil of the fossil remains of a large quadruped, now strange to our island, is, that the carcase of such animal had been drifted hither from some distant region. Prof. Owen alluded, in refutation of this idea, to the evidence which Dr. Buckland had brought forward of the long-continued habitation by hyenas of the Kirkdale cave in Yorkshire; of the remains of young mammoths, rhinoceroses, and hippopotamuses, that had been dragged into the cave, and their devoured, or their bones knawed, by the hyenas. Amongst other phenomena he particularly adduced the following: it is well known that the antlers of deer are shed and renewed annually, and a male may be reckoned to leave about eight pairs of antlers besides its bones to testify its former existence upon the earth; but as the female has usually no antlers, we may expect to find four times as many pairs of antlers as skeletons in the superficial deposits of the countries in which such deer have lived and died. The proportion of the fossil antlers of the great extinct species of British pliocene deer, which antlers are proved by the form of their base to have been shed by the living animals, is somewhat greater than in the above calculation. Although, therefore, the swollen carcase of a great exotic might be borne along a diluvial wave to a considerable distance, and its bones ultimately deposited far from its native soil, it is not likely that the solid shed antlers of such species of deer should be carried by the same cause to the same distance, or rolled for any distance, with other heavy debris of a mighty torrent, without fracture and signs of friction. But the shed antlers of the large extinct species of deer found in this island and in Ireland have commonly their points or branches entire, as when they fell; and the fractured specimens are generally found in caves, and show marks of the teeth of the hyenas, by which they have been knawed; thus at the same time revealing the mode in which they have become introduced into those caves, and proving the contemporaneous existence of both kinds of mammalia. The perfect condition, and the sharply defined processes, often in high relief, of many of the bones of the elephants, rhinoceroses, and hippopotamuses, from our tranquil fresh-water deposits, concur with the nature of their bed to refute the hypothesis of their having been borne hither by a diluvial current from regions of the earth where the same genera of quadrupeds are now limited. The very abundance of their fossil remains in our island is incompatible with the notion of their forming its share of one generation of tropical beasts drowned and dispersed by a single catastrophe of waters. This abundance indicates, on the contrary, that the deposits containing them formed the grave-yard, as it were, of many successive generations. With regard to the mode of introduction of this latest and most extensive series of quadrupeds, it could hardly be supposed that the ponderous rhinoceroses, the hyenas, wolves, foxes, badgers, oxen, horses, hogs, and goats, the smaller deer, hares, rabbits, pikas, or even the aquatic rodents, could have reached this island from the continent, if the present oceanic barrier had interposed. The idea of a separate creation of the same series of mammalia which existed on the continent in and for a small contiguous island will hardly be accepted. The zoologist Desmarest deduced an argument in proof that France and England were once united, from the correspondence of their wolves, bears, and other species known to have existed in this island within the period of history. Prof. Owen deemed the conclusion irresistible when the same correspondence was found to extend through the entire series of proboscidian, pachydermal, equine, bovine, cervine, carnivorous, and rodent mammalia, which characterised the two countries during the pliocene and post-pliocene periods of geology. Thus, observed the lecturer, the science of anatomy having revealed the great fact of the former existence in our present island of the same species of quadrupeds, most of which are now extinct, that co-existed on the continent, has become in an unexpected degree auxiliary to geographical science, and throws light upon the former physical configuration of Europe, and on the changes which it has since undergone.

Geographic Union of England and France.

Prof. Owen then briefly touched upon the purely geological evidence of the former union of England with the continent, and to the comparatively modern period of some remarkable changes which have taken place on our southern coast, and to which may be attributed the final establishment of the British Channel. But in referring to that event as comparatively recent, the term, he said, must not be judged of in relation to any such insignificant fraction of the world's time as has been marked down in the records of the present infancy of the human race: we shall better appreciate it, perhaps, by recalling the ideas of perpetuity which we attach to our ocean barrier, when, gazing on its waves, we sum up the known changes which they have produced on the coast line within the period of history or tradition. The indications of such changes, mighty in comparison with any of which human history takes cognisance, prepare us to view with less surprise the corresponding changes which have taken place in the mammalian fauna; but we are still ignorant of the cause of the extirpation of so large a proportion of it as has become extinct. It is an important fact, however, that a part, and not the whole, has thus perished, and that the cause has not been a violent and universal catastrophe, from which none could escape but by miraculous intervention. There is no small analogy, indeed, between the course of the extirpation of the pliocene mammals and that which history shews to have affected the wild animals of continents and islands in connexion with the progress of man's dominion. The largest, most ferocious, and the least useful of the pliocene species have perished; but the horse, the hog, probably the smaller species of wild ox, the goat, and many of the diminutive quadrupeds, remain. There is not, however, any satisfactory evidence that the human species existed when the mammoth, the tichorine and leptorhine rhinoceros, and the great northern hippopotamus, became extinct. It is probable that the horse and ass are descendants of species of pliocene antiquity in Europe:

there is no anatomical character by which the present wild boar can be distinguished specifically from that which was contemporary with the mammoth. The reindeer has, relatively to Britain, been exterminated, nor will our present climate permit its existence here. With the diminution of the great herbivora, which would naturally follow the limitation of their range when England became an island, that of the carnivora, dependent on them for food, would inevitably follow. And not here only, but likewise on the great continent over which they ranged, which would indicate that the extirpating cause, if it were extrinsic to their own constitution, had been due to changes of the earth's configuration and climate much more extensive than could be connected with the insulation of so small a portion of Europe as Britain.

Thus, continued the Professor, in the endeavour to trace the origin of our existing mammalia, I have been led, by long researches on the fossils of this island, to view them as descendants of a fraction of a peculiar and extensive mammalian fauna which overspread Europe and Asia at a period geologically recent, yet incalculably remote and long anterior to any evidence on record of the human race. It would appear, indeed, from the comparisons which the present state of palæontology permits to be instituted between the recent and extinct mammalian faunæ of other great natural divisions of the dry land, that these divisions also severally possessed a series of mammalia as distinct and peculiar in each during the pliocene period as at the present day.

Comparison with the Extinct Animals of other Countries.

When such a comparison is restricted to the fauna of a limited locality, especially an insular one like Great Britain, the discrepancy between the pliocene extinct and the existing groups of mammalia appears to be extreme. But if we regard Great Britain in connexion with the rest of Europe, and if we extend our view of the geographical distribution of extinct mammals beyond the limits of technical geography,—and it needs but a glance at the map to detect the artificial character of the line which divides Europe from Asia,—we shall then find a close and interesting correspondence between the extinct Europæo-Asiatic mammalian fauna of the pliocene period and that of the present day. The very fact of the pliocene fossil mammalia of England being almost as rich in generic and specific forms as those of Europe leads, as already stated, to the inference that the intersecting branch of the ocean which now divides this island from the continent did not then exist as a barrier to the migration of the mastodons, hippopotamuses, bisons, bears, &c., which have left such abundant traces of their former existence in the superficial deposits and caves of Great Britain. Now it is a most interesting fact, that in the Europæo-Asiatic expanse of dry land species continue to exist of nearly all those genera which are represented by pliocene and post-pliocene mammalian fossils of the same natural continent and of the immediately adjacent island of Great Britain.

America.

If we turn our attention to a more distant natural continent—South America, for example—we shall find that at the present day South America alone, is inhabited by species of which no fossil remains have yet been discovered in Europe, Asia, or Africa. In South America not a single fossil is referable to a true old world *mus*, though numbers of the common rat and mouse have been imported into South America since its discovery by Europeans.

In North America the most abundant mammalian fossils of the corresponding recent geological epoch belong to a species of mastodon (*M. giganteus*) peculiar to that continent. Since, however, North America borders closely upon Asia at its northern basis, and is connected by its opposite apex with South America, it perfectly accords with the analogies of the geographical relations of the last-extirpated series of mammals of the old world that the Asiatic mammoth and the South American megatherium should have migrated from opposite extremes, and have met in the temperate latitudes of North America, where, however, their remains are much more scanty than in their own proper provinces.

Australia.

Australia, in like manner, yields evidence of an analogous correspondence between its last extinct and its present aboriginal mammalian fauna, which is the more interesting on account of the very peculiar organisation of most of the native quadrupeds of that division of the globe. The first collection of mammalian fossils from the ossiferous caves of Australia brought to light the former existence on that continent of larger species of the same peculiar marsupial genera; some, as the thylacine, and the dasyurine sub-genus represented by the *Das. ursinus*, are now extinct on the Australian continent; but one species of each still exists on the adjacent island of Tasmania; the rest of the fossils were extinct wombats, phalangers, potoroos, and kangaroos—some of the latter being of gigantic stature. Subsequently, and after a brief interval, we obtain a knowledge of the former existence of a type of the marsupial group, exemplified by the genera *Diprotodon* and *Nototherium*, which represented the pachyderms of the larger continent, and which seems now to have disappeared from the face of the Australasian earth.

The most remarkable local existing fauna, in regard to terrestrial vertebrated animals, is that of the islands of New Zealand, with which geologists have been made familiar by Mr. Lyell's indication of its close analogy with the state of animal life during the period of the Wealden formation. The only terrestrial mammalian quadruped hitherto discovered in New Zealand, whose recent introduction into that island is at all doubtful, is a small rat. The unequivocally indigenous representatives of the warm-blooded vertebrata are birds, of which the apteryx is the most peculiar. It is the smallest known species of the struthious or wingless order, has the feeblest rudiments of the anterior members, and not any of its bones are permeated by air-cells. This bird forms the most striking and characteristic type of the proper or primitive fauna of New Zealand.

Not a trace of a fossil quadruped has been found in New Zealand; but our present knowledge of the living and the last-exterminated faunæ of the warm-blooded animals of that small but far-distant and isolated portion of earth, shows that the same close analogy existed betwen them as has been exemplified in the corresponding faunæ of larger natural divisions of the dry land on the present surface of this planet.

These Animals cannot have been derived from a common Asiatic centre.

Thus the facts obtained from a study of the fossil remains of mammalian quadrupeds, applied to a scientific consideration of the present distribution of the highest organised and last-created class of animals, demonstrate that, with extinct as with existing mammalia, particular forms were assigned to particular provinces, or natural divisions of the dry land of this globe; and what is still more interesting and suggestive, that the same forms were restricted to the same provinces at the pliocene period as they are at the present day. In pursuing the retrospective comparison of recent mammals to those of the eocene and oolitic strata, in relation to their local distribution, we obtain indications of extensive changes in the relative position of sea and land during those epochs, in the degree of incongruity between the generic forms of the mammalia which then existed in Europe, and any that are now found on the great natural continent of which Europe forms part. It would appear, indeed, from our present knowledge, that the further we penetrate into time for the recovery of extinct mammalia, the further we must go into space to find their existing analogues. To match the eocene palæotheres and lophiodons, we must bring tapirs from Sumatra or South America,—we must travel to the antipodes for myrmecobians and dasyures, the nearest living analogues to the amphitheres and phascolotheres of the ancient oolites. From what ancient centre, if any, the first types of the primary groups of the class mammalia may have radiated, we seem ever destined to remain ignorant, by reason of the enormous alterations of land and sea that have come to pass since the class was first introduced into our planet. We find, however, that from the period when the great masses of dry land assumed the general form and position that they now present, the same peculiar forms of mammalia characterised their respective faunæ. If we carry our retrospect no further back than the pliocene tertiary period, the evidence of the distribution of the recent and extinct mammalia would justify the conclusion that New Zealand, Australia, South America, and the old world or the geographers, had been as many distinct centres of creation. The difficulties that beset the commonly received view are insurmountable. According to the hypothesis that all existing land-animals radiated from a common Asiatic centre within the historical period, we must be prepared to admit that the nocturnal apteryx, which can neither fly nor swim, migrated across wide seas, and found its sole resting-place in the island of New Zealand, where alone the remains of similar wingless birds have been found fossil;—that the wombats, dasyures, and kangaroos should have as exclusively travelled to Australia, where only have been found, in pliocene strata and bone caves, the remains of extinct and gigantic species of the same genera or families of marsupialia; and that the modern sloths, armadillos, and anteaters, should have chosen the route to South America, where only, and in the warmer parts of North America, are to be found the fossil remains of extinct species of those very peculiar edentate genera. It is not less striking and suggestive, though at first sight less subversive of the recent-dispersion theory, to find the elephant, rhinoceros, hippopotamus, hyena, beaver, pika, hare and rabbit, vole and mole, still restricted to that great natural division of dry land to which the fossil remains of the same genera or species appear to be peculiar.

Mr. Lyell's Lecture on the Mississippi Delta.

Mr. Lyell delivered an evening discourse on the delta and alluvial deposits of the Mississippi, and other points in the geology of North America, observed in the years 1845-6. The delta of the Mississippi may be defined as that part of the great alluvial plain which lies below or to the south of the branching off of the highest arm of the river, called the Atchafalaya. This delta is about 13,600 square miles in arrear, and elevated from a few inches to ten feet above the level of the sea. The greater part of it protrudes into the Gulf of Mexico, beyond the general coast line. The level plain to the north, as far as Cape Girardeau, in Missouri, above the junction of the Ohio, is of the same character, including, according to Mr. Forshay, an area of about 16,000 square miles, and is therefore larger than the delta. It is very variable in width from east to west, being near its northern extremity, or at the mouth of the Ohio, 50 miles wide, at Memphis 30, at the mouth of the White River 80, and contracting again farther south, at Grand Gulf, to 33 miles. The delta and alluvial plain rise by so gradual a slope from the sea as to attain, at the junction of the Ohio, a distance of 800 miles by the river, an elevation of only 200 feet above the Gulf of Mexico.

Mr. Lyell first described the low mud-banks covered with reeds at the mouths of the Mississippi, and the pilot-station called the Balize, then passed to the quantity of drift-wood choking up some of the bayous, or channels,

HALL'S BRICK MACHINE.

Fig. 1.

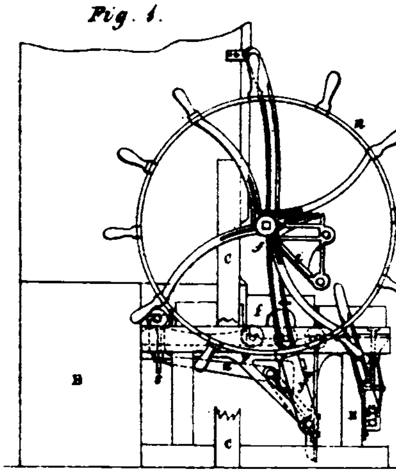


Fig. 3.

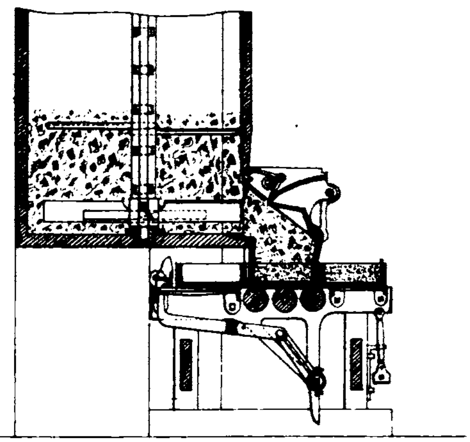


Fig. 2.

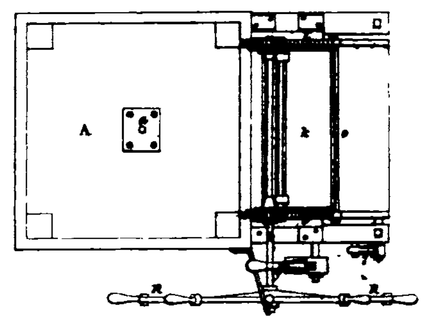


Fig. 5.

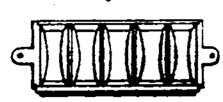
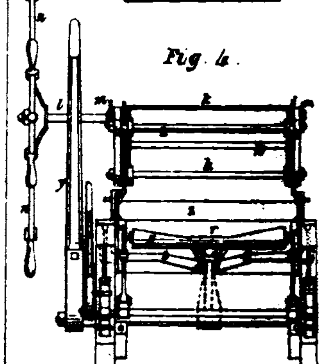


Fig. 4.



BENSON'S TILE MACHINE.

Fig. 1.

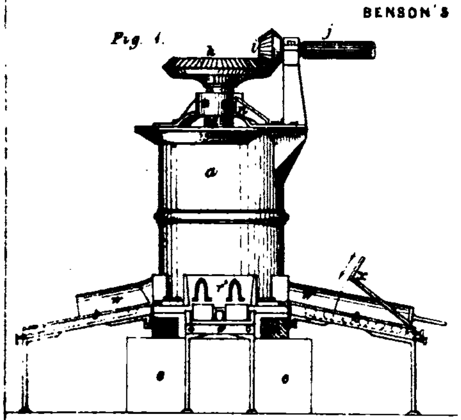


Fig. 2.

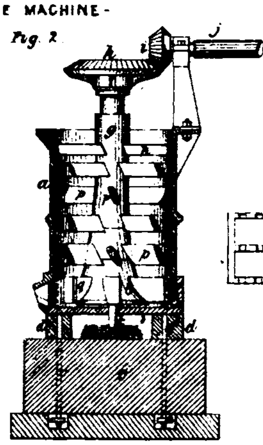
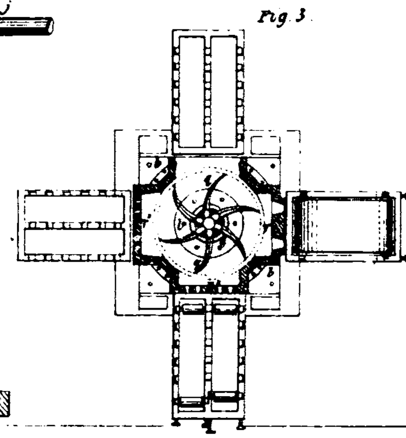


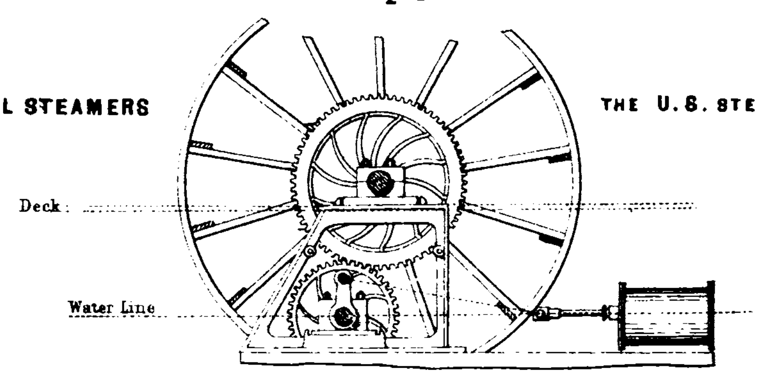
Fig. 3.



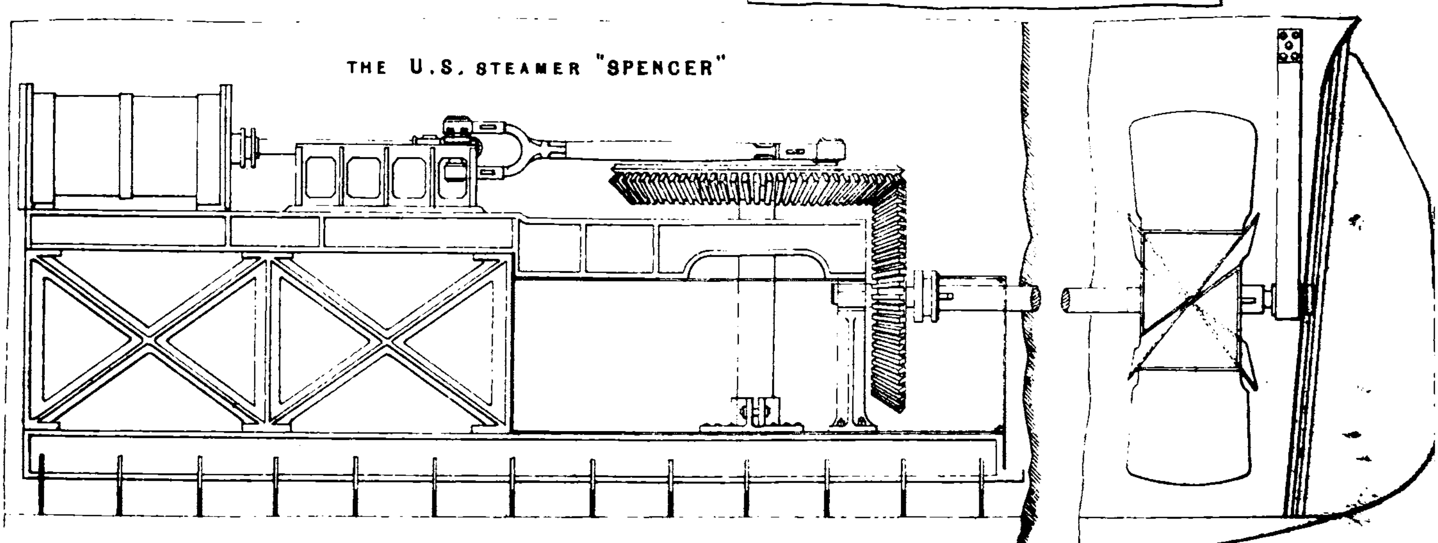
EXPERIMENTS WITH SCREW & PADDLE WHEEL STEAMERS IN AMERICA.

Scale ¼ Inch to a Foot.

THE U.S. STEAMER "McLEAN"



THE U.S. STEAMER "SPENCER"



intersecting the banks, and lastly enlarged on the long narrow promontory formed by the great river and its banks between New Orleans and the Balize. The advance of this singular tongue of land has been generally supposed to have been very rapid; but Mr. Lyell and Dr. Carpenter, who accompanied him, arrived at an opposite conclusion. After comparing the present state of this region with the map published by Charlevoix 120 years ago, they doubt whether the land has, on the whole, gained more than a mile in the course of a century. A large excavation, eighteen feet deep, made for the gas-works at New Orleans, and still in progress in March 1846, shows that much of the soil there consists of fine clay or mud, containing innumerable stools of trees, buried at various levels, in an erect position, with their roots attached, implying the former existence there of fresh-water swamps, covered with trees, over which the sediment of the Mississippi was spread during inundations, so as slowly to raise the level of the ground. As the site of the excavation is now about nine feet above the sea, the lowest of these upright trees imply that the region where they grew has sunk down about nine feet below the sea-level. The exposure also in the vertical banks of the Mississippi at low water, for hundreds of miles above the head of the delta, of the stumps of trees buried with their roots in their natural position, three tiers being occasionally seen one above the other, shews that the river in its wanderings has opened a channel through ancient morasses, where trees once grew, and where alluvial matter gradually accumulated. The old deserted bed also of the river, with its banks raised fifteen feet above the adjoining low grounds, bears testimony to the frequent shifting of the place of the main stream; and the like inference may be drawn from the occurrence here and there of crescent-shaped lakes, each many miles in length, and half a mile or more in breadth, which have once constituted great curves or bends of the river, but are now often far distant from it. The Mississippi, by the constant undermining of its banks, checks the rise of large commercial towns on its borders, and causes a singular contrast between the wealth and splendour of 800 or more fine steamers, some of which may truly be called floating palaces, and the flat monotonous wilderness of uncleared land which extends for hundreds of miles on both sides of the great navigable stream.

Mr. Lyell visited, in March 1846, the region shaken for three months in 1811-12 by the earthquake of New Madrid. One portion of it, situated in the states of Missouri and Arkansas, is now called the sunk country. It extends about seventy miles north and south, and thirty east and west, and is, for the most part, submerged. Many dead trees are still standing erect in the swamps, and a far greater number lie prostrate. Even on the dry ground in the vicinity all the forest trees which are of prior date to 1811 are leafless; they are supposed to have been killed by the loosening of their roots by the repeated shocks of 1811-12. Numerous rents are also observable in the ground where it opened in 1811, and many "sink holes," or cavities, from ten to thirty yards wide, and twenty feet or more in depth, interrupt the general level of the plain, which were formed by the spouting out of large quantities of sand and mud during the earthquake.

Formation of the Delta occupied 67,000 years.

In attempting to compute the minimum of time required for the accumulation of the alluvial matter in the delta and valley of the Mississippi, Mr. Lyell referred to a series of experiments made by Dr. Riddell at New Orleans, showing that the mean annual proportion of sediment in the river was to the water $\frac{1}{1245}$ in weight, or about $\frac{1}{3000}$ in volume. From the observations of the same gentleman, and those of Dr. Carpenter, and of Mr. Forshay, an eminent engineer of Louisiana, the average width, depth, and velocity of the Mississippi, and thence the mean annual discharge of water were deduced. In assuming 528 feet, or the 10th of a mile, as the probable thickness of the deposit of mud and sand in the delta, Mr. Lyell founds his conjecture on the depth of the Gulf of Mexico between the southern point of Florida and the Balize, which equals on an average 100 fathoms. The area of the delta being about 13,600 square statute miles, and the quantity of solid matter annually brought down by the river, 3,702,758,400 cubic feet, it must have taken 67,000 years for the formation of the whole; and if the alluvial matter of the plain above be 264 feet deep, or half that of the delta, it has required 33,500 more years for its accumulation, even if its area be estimated as only equal to that of the delta, whereas it is in fact larger. If some deduction be made from the time here stated in consequence of the effect of the drift-wood which must have aided in filling up more rapidly the space above alluded to, a far more important allowance must be made, on the other hand, for the loss of matter, owing to the finer particles of mud not settling at the months of the river, but being swept out far to sea, and even conveyed into the Atlantic by the Gulf stream. Yet the whole period during which the Mississippi has transported its earthy burden to the ocean, though perhaps far exceeding 100,000 years, must be insignificant in a geological point of view, since the bluffs, or cliffs, bounding the great valley, and therefore older in date, and which are from 50 to 250 feet in perpendicular height, consist in great parts of loam containing land, fluviatile, and lacustrine shells, or species still inhabiting the same country. These fossil shells, occuring in a deposit resembling the loess of the Rhine, are associated with the bones of the mastodon, elephant, tapir, mylodon, and other megathoid animals; also a species of horse, ox, and other mammalia, most of them extinct species. The loam rests at Vicksburg and other places on eocene or lower tertiary strata, which in their turn repose on cretaceous rocks. A section from Vicksburg to Darien, through the states of Mississippi, Alabama, and Georgia, exhibits this superposition, as well as that of the cretaceous strata on carboniferous rocks at Tuscaloosa. Mr. Lyell ascertained that the huge fossil cetacean named Zeuglodon by Owen is confined to the cocene deposits. In the cretaceous strata the remains of the mosasaurus and other reptiles occur without any cetecea. The coal-fields of Alabama were next alluded to, from which fossil plants have been procurred by Professor Brumby and Mr. Lyell, of the genera sphenopteris, neuropteris, calamities, lepidodendron, sigillaria, stigmaria, and others, most of them identical in species, as determined by Mr. C. Bunbury, with fossils of Northumberland. This fact is the more worthy of notice, because the coal of Tuscaloosa, situated in latitude 33° 10′ north, is farther south than any region in which this ancient fossil flora had previously been studied, whether in Europe or North America; and it affords, therefore, a new proof of the wide extension of a uniform flora in the carboniferous epoch. Mr. Lyell, adverting to the opinion recently adopted by several idle botanists, that the climate of the coal period was remarkable for its moisture, equability, and freedom from cold, rather than the intensity of its tropical heat, stated that this conclusion, as well as the oscillations of temperature implied by the glacial period, is confirmatory of the theory first advanced by him in 1830, to explain the ancient geological changes of climate by geographical revolutions in the position of land and sea.

The lapse of ages implied by the distinctness of the fossils of the eocene, cretaceous, carboniferous, and other strata is such, that were we to endeavour to give an idea of it, we must estimate its duration not by years, as in the case of the delta, but by such units as would be constituted by the interval between the beginning of the delta and our own times.

Doctrine of the earth's antiquity not to be refuted by prejudice.

"It is now fifty years," said Mr. Lyell, "since Playfair, after studying the rocks in the neighbourhood of Edinburgh in company with Dr. Hutton and Sir James Hall, was so struck with the evidences they afforded of the immensity of past time, that he observed, 'How much farther reason may go than imagination can venture to follow!' These views were common to the most illustrious of his contemporaries, and since that time have been adopted by all geologists, whether their minds have been formed by the literature of France or of Germany, or of Italy, or Scandinavia, or England; all have arrived at the same conclusion respecting the great antiquity of the globe, and that, too, in opposition to their earlier prepossessions, and to the popular belief of their age. It must be confessed that while this unanimity is satisfactory as a remarkable test of truth, it is somewhat melancholy to reflect that at the end of half a century, when so many millions have passed through our schools and colleges since Playfair wrote that eloquent passage, there should still be so great a discordance between the opinions of scientific men and the great mass of the community. Had there been annual gatherings such as this, where they who are entitl d to speak with authority address themselves to a numerous assembly drawn from the higher classes of society, who, by their cultivation and influence, must direct the education and form the opinions of the many of humbler station, it is impossible that so undesirable and unsound a state of things should have now prevailed, as that there should be one creed for the philosopher, and another for the multitude. Had there been meetings like this even for a quarter of a century, we should have already gained for geology the same victory that has been so triumphantly won by the astronomer. The earth's antiquity, together with the history of successive races of organic beings, would have been ere this as cheerfully and universally acknowledged as the earth's motion, or the number, magnitude, and relative distances of the heavenly bodies. I am sure it would be superfluous if I were to declare, in an assembly like this, my deep conviction which you—all of you—share, that the farther we extend our researches into the wonders of creation in time and space, the more do we exalt, refine, and elevate our conceptions of the Divine Artificer of the universe.

Mr. Lyell concluded this discourse by announcing his corroboration of the discovery recently made by Dr. King at Greensburg, thirty miles from Pittsburg in Pennsylvania, of the occurrence of fossil footprints of a large reptilion in the middle of the ancient coal measures. They project in relief from the lower surface of slabs of sandstone, and are also found impressed on the subjacent layers of fine unctuous clay. This is the first well-established example of a vertebrated animal more highly organised than fishes being met with in a stratum of such high antiquity.

COMPARISON OF SCREW PROPELLERS AND PADDLE WHEELS.

(With Engravings, see Plate XVI.)

The Board of Engineers of the United States Navy having been officially directed to inquire respecting the merits of different methods of propelling steam-vessels, presented, at the commencement of the present year two reports (dated in January and May respectively), detailing the result of their enquiries. We are enabled to give the following analysis of these documents.

The first report contains a comparison of the relative effects and values of "Hunter's" and "Loper's" propellers, deduced from the performances of a revenue steamer fitted in the first experiment with the former of these propellers, and subsequently with the latter of them.

The second report compares the effect of Loper's propeller with that of the ordinary paddle-wheel fitted into two vessels of exactly the same size and dimensions. The section fig. 1, plate XVI. will show the plan of gearing on board the *Spencer* (the screw vessel). The steam cylinder is horizontal, and the connecting rod drives a horizontal bevil wheel, which takes into a vertical bevil wheel on the same with the screw-propeller. The propellers are therefore two in number; they project from either quarter of the vessel. The mode of gearing here adopted seems to possess peculiar advantages. It is well known to engineers that bevil wheels *run lighter* than the ordinary spur-wheels, and indeed it may be shown theoretically that they have, *cæteris paribus*, less friction; moreover the teeth of the former will generally, come in contact more gradually and consequently with less concussion and noise. This mode of gearing has also the advantage of compactness and affords peculiar facilities of construction where the cylinders are horizontal.

The vertical wheel contained 75 wooden cogs and the horizontal wheel 60 iron cogs. There seems a slight error of detail in making the numbers of cogs in each wheel bear the relation here stated. In general the respective number should be *prime* to each other, that is, should not contain a common measure. The greatest common measure of 75 and 60 is 15, and consequently instead of each tooth in the one wheel coming into contact with each tooth in the other during successive revolutions, it happens that by the time one wheel has revolved 4, and the other 5 times, the contact of the same teeth commences again. By the contrivance of a "hunting-cog," that is, an additional tooth, in the smaller wheel the numbers (75 and 61) become prime to each other, and this disadvantage is avoided. Cog-wheels driving screw propellers are subject to so much wear and tear that no expedient for diminishing the evil ought to be neglected.

The plan of gearing on board the *McLane*, fitted with paddle-wheels, is exhibited in fig. 2, plate XVI. The cylinder is horizontal as before. On the engine shaft is a pinion of 47 teeth taking into a wheel on the upper shaft of 72 wooden teeth; the wheel and pinion are in diameter 7 feet and 4½ feet respectively, and concussion or jar is diminished by forming each of two similar wheels 8 inches wide with the teeth off-set. The pinion and the wheel driven by it have therefore each a face 16 inches wide. The following extract from the reports will give the remaining particulars.

Dimensions of Vessels, Engines, Propellers, &c.—*Vessels* (iron).

Length between perpendiculars	143	feet.
Beam at knuckle	18½	"
Beam at water line	22	"
Depth of hold	11	" 10 inches.
Displacement at load line	460	tons.
Area of *immersed section*	166	feet.

Engines—Two, non-condensing; *cylinders*, 24 inches diameter, by 3 ft. stroke of piston; steam, *cut* off at half stroke; one *boiler* containing 1,450 square feet of heating surface *combustion*, anthracite coal aided with a blast.

Power.—The horses power of the engines is estimated by the formula—$\frac{S\times(P-f+14\cdot7)}{33,000}$, where S represents velocity of piston in feet per minute. P, means effective pressure upon cylinder piston in pounds, per square inch; and f, the friction of the engines, equal ⅛ of pressure upon steam gauge.

"*Spencer.*"—Two *screw propellers*, 8 feet in diameter, having four blades each, with an area of 11½ square feet on each side. Angle of blades at hub, from plane of axis, 30°; at edge of blade, 54°. Revolutions of propellers, 1¼ for each revolution of engines. Draft of water, 9 feet 8 inches.

"*McLane.*"—Two *side wheels*, 16 feet 5 inches in diameter, in trials 1, 2, 3, and 4, and 15 feet 1 inch in trials 5 and 6; 14 buckets in each wheel, 10 inches by 5 feet 11 inches each. Immersed area of buckets, in each wheel, 24 square feet. *Revolutions* of wheels, 65 for each 100 of engines. Draft of water, 9 feet 8½ inches.

The two vessels being almost identical in form, allowed a comparison by means of simultaneous experiments which were accordingly commenced in April by Capt. Fraser, under the supervision of Mr. Haswell, engineer-in-chief of the navy, and Commodore Perry. From Capt. Fraser's report we make the following extract:—

Great care was taken to trim both vessels as much alike as possible. The coal to be used was the best quality, anthracite, from the same mines, (Beaver Meadow).

Taking into consideration the very defective model of these vessels, and that the engines were constructed for, and particularly adapted to Hunter's submerged wheel, rendering it necessary to use cog wheel geering, no proper estimate of the speed attainable by the side wheel or propeller can be arrived at. Still, their relative value in speed and consumption of fuel may be very satisfactorily determined. It must be borne in mind that the diameter of the propeller, and consequently its effective power, is limited by the draft of water, in order to keep it entirely submerged, and at the same time above the line of the keel, while the diameter of the side wheel may be increased by raising the shaft, thereby increasing the speed.

In the McLane, however, the diameter of the wheels is as great as desirable for sea service.

Both vessels, as exhibited in the annexed drawings, are precisely similar in model and dimensions, and each is furnished with two high-pressure horizontal engines: diameter of cylinder 24, and length of stroke 36 inches.

A sketch of the half cross section of the vessels is hereunto appended, which will clearly exhibit to practical men, that speed under steam, or stability under canvas, are unattainable objects. Plans of the propellers and mode of gearing, are likewise given.

Each vessel is furnished with a single boiler, having 1,450 feet fire surface. The Spencer is furnished with two of Loper's propellers, one projecting from each quarter, and the McLane with side wheels, having 14 buckets each. All the dimensions of the propellers and wheels are hereafter given, and the draft of water, dip of buckets, &c., are exhibited in tabular form, with each day's trial. The buckets of the side wheel were, at the suggestion of Messrs. Haswell and Coney, moved eight inches towards the centre, before making the trial on the last day.

It will be perceived by reference to the drawings, that the relative revolutions of the engines and wheels of the McLane, are as 1 of the former to ·6528, while the relative revolutions of the engines and propellers of the Spencer are as 1 to 1·25. The greatest care was exercised in weighing the coal, and the pressure of steam, revolutions, times, &c., were carefully noted every fifteen minutes. The distances, set, and velocity of the tides, are given upon the authority of the superintendent of the coast survey, and the time of slack water, noted in each day's work.

The trial on the first day, from New London to Falkner's Island, and returning, was under, as nearly as possible, an uniform pressure of steam, and the safety valve was loaded with 45 pounds to the square inch. On the second day, the trial was made by confining the number of revolutions of the engines as nearly as possible to 35, and returning under 22½ pounds pressure of steam.

On the third day, as before mentioned, the buckets of the side wheels were moved eight inches towards the centre, increasing the revolutions under the same pressure, in order to ascertain whether the increased speed attained was commensurate with the increased consumption of fuel, and at the same time to ascertain what distance each vessel could be propelled with 2,000 pounds of coal. This portion of the trial was quite interesting. The second propeller of the Spencer did not stop until the steam gauge exhibited a pressure of but two pounds.

On the first day a strong gale prevailed from the westward, with a turbulent head sea, reducing all the sailing vessels in sight, which were working to windward, to double reefs, and the great differences exhibited in consumption of fuel and speed, between the passage from and returning to the light boat, was doubtless produced by the resistance offered by the wheel-houses of the McLane, when steaming head to the wind, and the assistance afforded when before it, as well as the inefficient operation of wheels of so small diameter in a sea way, while the propeller being submerged was exercising the same effort at all times, and under all circumstances.

A trial of the sailing qualities was not deemed important, for experience has hitherto shown, that by the wind, this model has neither speed or stability.

A full and detailed journal of the trials is next given, but it is not necessary to make an abstract of it, as the general results are included in the official reports of the Engineer-in-chief and Commodore Perry. The joint report of those gentlemen is as follows:—

Washington, D. C., May 18th, 1846.

Sir,—In the execution of instructions contained in your letters of the 8th ultimo, the undersigned proceeded to New London, Conn., for the purpose of witnessing some experiments that were to be made by order of the Treasury Department, with the Revenue Steamers "Spencer" and "Mc Lane," the former fitted with two of Loper's propellers (screw), the latter with the ordinary side wheels.

Upon our arrival at that place, we were met by Capt. A. V. Fraser, temporarily in command of the "Spencer," under whose directions the experiments were to be made—and also by Capt. W. A. Howard, in command of the "McLane," who, in conjunction with the former, afforded us every practicable facility in the prosecution of the object of our attendance.

The necessary preliminary arrangements being made, and the two vessels having been brought to a similar draft of water, and provided with similar fuel (anthracite), it was decided that the trials made, should be to determine the following points:

2. The relative speed of the vessels, and consumption of fuel, with equal pressures of steam, when running under various circumstances of wind and weather.

2. The same points as above, the engines of the "Spencer" being reduced in speed to assimilate, as far as practicable in power, to those of the "McLane."

3. The same points, with the pressures of steam reduced one-half.

4. The effect of the consumption of an equal quantity of fuel (2,000 lb.) with similar initial pressures.

The elements for a comparison of the two vessels, regarding their form, &c., are as follows:—

The hulls, engines, and boilers were constructed from duplicate drawings. One vessel had three and the other two masts, adapted for equal surfaces of canvas. This difference of rig. however, could not in the least have influenced the results of the trials; and especially so, as the vessels were not tried under canvass. The instruments of cutting off the steam differed in some degree,—that of the "Spencer" being a slide valve, and that of the "McLane" a puppet. In the spaces between the grate-bars, there was also a variance, those of the "Spencer" being the greatest, and consequently effecting a greater waste of fuel. The geering of the engines, propellers, and wheels, was similar in its character (cogged wheels), the only mechanical difference being that necessarily due to the peculiar means of propulsion.

The bottoms of the vessels, and the engines and boilers, were, as far as our observation extended, aided with the information received respecting them, in equally good order.

Respecting the proportions of the different propellers, it was clearly shown that they were of sufficient diameter and surface for the purpose intended. There was a point, however, connected with their application which in our opinion materially interfered with the speeds of the vessels, arising from the relative speeds of the engines, and each of their attached propellers. Had the engines been geered so as to have worked faster with equal pressures, there would have been a material increase of power (as the boilers of the vessels were capable of supplying a greater quantity of steam than that they were restricted to in these trials). Had this disadvantage been similar, it would alone have effected the rate of speed; but as it occurred, the engines of the "McLane" were geered so as to preclude the attainment of a power with similar pressure equal to that of the "Spencer." The effect of this, however, is duly considered in determining the results given in statement C, which was prepared by C. H. Haswell; as a substitute for which, M. C. Perry submits statement D; while to those marked A and B, we refer you for details of the information on various points indicated in your letters.

M. C. Perry, *Engineer-in-chief U. S. Navy.*
C. H. Haswell,

Commodore Charles Morris,

Chief of Bureau of Construction, &c., Washington, D. C.

From the concluding sentence it appears that a difference of opinion existed as to the *conclusiveness* of the experiments: the separate statements [C] and [D] refer to those points on which a difference of opinion existed, and are submitted, the former by the Engineer-in-Chief, the latter by Commodore Perry.

[C.]

Results of the Comparisons deduced from the Preceding Elements.

In these the consumption of fuel is not considered, for reasons which will appear obvious when presented.

1. The boilers and engines being identical in capacities, the amount of steam used in the engines is an exact measure of the expenditure of each means of propulsion, which amount is estimated in the calculations of power here given.

2. The steam required was so much below the actual capacities of the boilers to furnish it, and so nearly alike in its quantities, that a hurried combustion of the fuel was unnecessary. Hence the waste consequent upon rapid combustion was not only not incurred in either vessel, but was not incurred by either means of propulsion at the risk of its economy compared with the other.

3. The omission of this element sets aside the effects of the difference in the grate-bars, and of any difference in firing by different individuals.

The computation then, of the powers of the engines is considered a fair and proper exponent of the cost of propulsion; while the cubes of the speeds are taken as the measures of the effects produced, which elements, (those of power and effect) being reduced for each trial, the following deductions are furnished:—

First.—In this trial, the application in the "Spencer" was 1·52 to 1 more efficient than that in the "McLane."

Second.—In this trial, the application in the "Spencer" was 1·14 to 1 more efficient than that in the "McLane."

Third.—In this trial, the application in the "McLane" was 1·16 to 1 more efficient than that in the "Spencer."

Fourth.—In this trial, the application in the "McLane" was 1 to ·82 more efficient than that in the "Spencer"

Fifth.—In this trial the application in the "Spencer" was 1·04 to 1 more efficient than that in the "McLane."

Sixth.—In this trial, the application in the "Spencer" was 1·03 to 1 more efficient than that in the "McLane."

[D.]

"Having stated in the foregoing papers all the particulars connected with the experimental trials of the steamers "McLane" and "Spencer," I find in passing them in review a difficulty in forming any definite conclusions upon the subjects under inquiry.

Notwithstanding the care with which the trials were made under the skilful management of Captains Fraser and Howard, very little of a satisfactory character was elicited. On the contrary, the results tended rather to confuse than to elucidate: certainly they furnished no criterion by which to determine the relative properties of the propeller and the side wheels, and the causes may, in my judgment, be justly ascribed to the defective form of the bottoms of the vessels.

It may be assumed by some, that as the models and dimensions of the two vessels were precisely alike, and the steam force exerted upon their respective propelling power was the same, the results *ought* to be conclusive of the superiority of the propeller—but such is not my opinion.

Captains Fraser and Howard both affirmed, and I give much weight to their professional opinions, that neither vessel would stand up under canvas, that they would not stay under ordinary circumstances, and it was difficult to wear them within any reasonable space, or to keep them to the wind in heavy weather—that in fresh breezes, on the wind, the lee wheel of the "McLane" would be immersed almost to its axis: in a word, that they were unmanageable at sea, and in their belief would be unsafe if thrown upon a lee shore in a heavy gale, even if assisted by steam power.

It is plain, therefore, that no application, whether of steam power or sails, or both combined, to vessels of such unusual model, could by possibility produce any satisfactory results, illustrative of the question of relative merits of the two modes of propulsion: and this opinion is strengthened by the fact, that on the occasion of their first day of trial in the Sound, when there was a strong double-reef topsail breeze from the northward and westward, they were so slow in their movements, that all agreed that any fair *sailing* vessel would have worked from New York to Falkner's Island, and made the run back, in a less space of time than was occupied by the fastest of the two steamers in accomplishing it."

The general result of the experiments is given in the following table of the *Elements of Comparison of the various Trials*:—

The distances given are in nautical miles.

Trials 1 and 2.—Speed and consumption of fuel with equal pressures, and under various circumstances of wind and weather.

	OUT.		IN.	
	Spencer.	McLane.	Spencer.	McLane.
Average* pressure of steam in pounds, per square inch	42·3	47·	42·	46·
Average revolutions of engines per minute	41·5	24·5	42·	28·
Time of running, in hours and minutes ..	4 31	6 42	3 32	3 57
Distance run through the water in miles, the effect of the tide (2 knots) being estimated	24·25	27·75	22·85	22·4
Speed in miles per hour	5·4	4·14	6·48	5·67
Consumption of fuel in pounds per hour ..	1224	928	880	1176
Power of engines in horses	186	129	192	147

Trials 3 and 4.†—*Out.*—Speed and consumption of fuel, the pressure of steam in the "Spencer," being reduced in order to assimilate the power of the engines to those of the "McLane."

In.—Speed and consumption of fuel, the pressure of steam in both vessels, being equally reduced to 22·5 lb. per square inch.

	OUT.		IN.	
	Spencer.	McLane.	Spencer.	McLane.
Average pressure of steam per square inch, in pounds	39·	47·	23·	22·5
Average revolutions of engines per minute	35·	29·6	32·5	22·
Time of running, in hours and minutes ..	1 46	1 31	2 7	2 10
Distance run through the water in miles ..	11·25	10·23	9·8	9·4
Speed in miles per hour	5·36	6·78	4·62	4·84
Consumption of fuel in pounds per hour ..	360	990	588	172
Power of engines in horses	150	155	76	82

*Trials 5 and 6.***—*Out.*—Speed and duration of operation with similar quantities of fuel—2000 pounds of coal being allowed to each vessel.

In.—Speed and consumption of fuel under equal pressures and various circumstances of wind and weather.

	OUT.		IN.	
	Spencer.	McLane.	Spencer.	McLane.
Average pressure of steam in pounds per square inch	Valve loaded.	at 46 lb.	41·	48·
Average revolution of engines per minute..	——	——	45·	40·
Time of running, in hours and minutes ..	‖ 3 46	‖ 3 29	2 45	2 48
Distance run through the water in miles ..	23	22·7	19·8	19·8
Speed in miles per hour	——	——	7·2	7·07
Consumption of fuel in pounds per hour ..	‡	§	925	1260
Power of engines in horses	——	——	220	216

It will be observed that these "elements" do not include the amount of steam evaporated during the experiments. The formula given above for

* In these trials, the cut-off of the starboard engine of the "Spencer" was not used, the effect of which, however, is estimated, and the consumption of fuel given is in accordance with it.

† The throttles of the "Spencer's" engines were constantly closed, to reduce the revolutions in the run out. The effect of this is fully estimated, as the revolutions of the engines of this vessel were ascertained at such pressures as were necessary to determine it.

** In these trials the wheels of the "McLane" were reduced in diameter 16 inches.

‖ In this trial the distances run, and the times of running (equal distances), were very nearly alike, the difference being inappreciable. One of the engines of the "Spencer" continued working for several minutes after all the others had stopped, which increased the time of running of that vessel beyond the other.

‡ While coal lasted 950 lb.

§ While coal lasted 850 lb.

estimating the power of the engines is similar in form to that of Tredgold, and the cylinder pressure is deduced from the boiler pressure by a method independent of the omitted element: that is, the calculation proceeds on the assumption that the boiler pressure and cylinder pressure will bear a constant relation to each other, whatever may be the rate of evaporation. This assumption, De Pambour, in his Treatise on the Steam Engine, has shown to be erroneous, and he contends therefore that the whole of Tredgold's Theory of the Steam Engine is incorrect, and that his formulæ for computing the power of engines can never be correct, except by an accidental compensation of errors.—The views of De Pambour are now generally adopted by scientific men. We will venture at the risk of appearing to differ in some measure from the very high authorities by whom the reports before us are sanctioned, to apply De Pambour's method of calculation to one or two of the results of the experiments just described.

In the report dated January 31 (p. 3), we find the following comparison of two experiments :—

	Expt. (1).	Expt. (2).
Total boiler pressure per square inch	92·2 lb.	63·70 lb.
Revolutions of engine per minute ..	53·5	44·45
Fuel consumed per minute	36 lb.	21·66 lb.

It is assumed in the report that until the steam was cut off the cylinder-pressure was the same as that of the boiler. On De Pambour's principle, however, the conclusion would be very different. In absence of more accurate data we may suppose that since the form and dimensions of the boiler, &c., were identical in the two experiments each pound of coals evaporated effectively the same volume of water (M). Then

	Expt. (1).	Expt (2).
Cubic feet of water evaporated per minute ..	46 M	20·16 M

Now it appears from the table in De Pambour's Treatise on Locomotive Engines (p. 60), that steam at 92·2 lb. pressure occupies 316 times the volume of the water from which it is produced, and steam at 63·79 lb. pressure occupies about 444 times the space of the water from which it is produced. Therefore in the present case

	Expt. (1).	Expt. (2).
Cubic feet of steam evaporated per minute	46 M × 316 = 14536 M	20·16 M × 444 = 8951 M

The capacity of the cylinders was the same in both cases (= N), but in the first experiment the steam was cut off at one-third of the stroke, in the second at one-half of the stroke, consequently taking the number of revolutions of the engine per minute in each case, we have

	Expt. (1).	Expt. (2).
Cubic feet of steam admitted to cylinders per minute	33·5 × ⅓N = 17·83 N	44·45 × ½ N = 22·225 N

Comparing these quantities with the volumes of steam generated in the boiler, we see that in experiment (1) 14536 M cubic feet of steam at a pressure 92·2 lb. were dilated to occupy 17·83 N cubic feet: and in experiment (2) 8951 M cubic feet of steam at pressure of 63·79 lb. were dilated to occupy 22·225 N cubic feet. But by Mariotte's law the pressure of steam is inversely as the space occupied. Hence

$$\text{Expt. (1).} \qquad \frac{\text{Boiler pressure}}{\text{Cylinder pressure}} = \frac{17{\cdot}83\,N}{14536\,M} \qquad \text{Expt. (2).} \qquad = \frac{22{\cdot}225\,N}{8251\,M}$$

Hence we get finally the following relation:

$$\frac{\text{Cylinder pressure (1).}}{\text{Cylinder pressure (2).}} = \frac{\text{Boiler pressure (1).}}{\text{Boiler pressure (2).}} \times \frac{22{\cdot}225 \times 14536}{17{\cdot}83 \times 8951}$$

$$= \frac{\text{Boiler pressure (1).}}{\text{Boiler pressure (2).}} \times 2{\cdot}0208.$$

Showing that the proportion between the cylinder pressures before the steam is cut off, instead of being equal to the proportion between the boiler pressures will be *more than double that proportion*. This certainly seems to show the importance of taking into consideration the relative generation of steam in the boiler and consumption of it in the cylinder.

Let us take another case—the trials 5 and 6 in the second report of which the experimental results are given above. Adopting a method of calculation exactly the same as the foregoing, and considering that in the *Spencer* and *McLane* the cylinders were of the same size, that the steam in both was cut off at half-stroke, and that by De Pambour's table steam at 58·7 lb. occupies 480 times, and steam at 62·7 lb. occupies 450 times the volume of the water producing it—we have

	Expt.	Expt.
Total pressure in boiler	58·7 lb.	62 7
Revolutions per minute	45	40
Fuel consumed per minute	15·4 lb.	20·8
Cubic feet of water evaporated per minute ..	15·4 M	20·8 M
Cubic feet of steam evaporated per minute ..	15·4 M × 480 = 7392 M	20·8 M × 450 = 8360 M
Cubic feet admitted to cylinder per minute ..	½ N × 45	½N × 40
Cylinder pressure / Boiler pressure	7392 M / 22·5 N	8360 M / 20 N

Hence we get the relation

$$\frac{\text{Cylinder pressure (McLane)}}{\text{Cylinder pressure (Spenser)}} = \frac{\text{Boiler pressure (McLane)}}{\text{Boiler pressure (Spencer)}} \times \frac{8360 \times 22{\cdot}5}{7392 \times 20}$$

$$= \frac{\text{Boiler pressure (McLane)}}{\text{Boiler pressure (Spencer)}} \times 1{\cdot}27$$

That is the proportion of the cylinder pressures before the steam is cut off is not that of the boiler pressures, but upwards, of one-fourth more.

The actual relatioo of the boiler pressure to the cylinder pressure in *each* engine is immediately ascertained by giving M and N their proper values —that is, by substituting the size of the cylinder, and the evaporative effect of each pound of coke. It would however generally be more accurate to ascertain the total quantity of water evaporated during the trial, and make a correction for priming according to the method detailed by De Pambour.

We are indebted to the courtesy of an American correspondent for copies of the reports alluded to. The source from which this favour comes, and the very flattering manner in which it is conferred, greatly enhance its value, and induce us to hope that notwithstanding differences of opinion between American and English engineers, we shall have hereafter further opportunities of recording the investigations of our transatlantic fellow labourers in the advancement of practical science.

METROPOLITAN SEWAGE MANURE.

The select committee, which was appointed last session to consider sundry plans for the application of the sewage of the metropolis to agricultural purposes, reported in favour of the Metropolitan Sewage Manure Company Bill, which has since passed into a law, with certain modifications. They declined to recommend its postponement or rejection for the sake of Mr. Wicksted's plan, for carrying off the entire sewage of London, in a tunnel of from eight to twelve feet in diameter, and at a depth of from 40 to 80 feet under the level of the streets, being of opinion that the first experiment of dealing with sewage water had better be tried upon a smaller scale and at a less formidable expense; and, as regarded Mr. Higgs' plan, they conceived that the public mind was not at present prepared to risk the establishment of any such reservoirs as he proposed to construct, although, by the precautions he contemplated, he would probably preclude the possibility of any deleterious or offensive consequences. It appeared, indeed, that the main ground of complaint against the bill by the owners or occupiers of land was, that power had been taken in it to construct reservoirs or tanks for the reception of stagnant and offensive sewage water. That power was, in consequence, relinquished by the promoters. The committee, however, seemed to concur in the propriety of such a step out of deference to public feeling only, being of opinion that the loss of such a provision would, in some degree, impair the efficiency of a measure which proposed at all times to remove from the Thames the daily-increasing refuse of London. As explained by Mr. Smith, of Deanston, the operations of the company are to be limited to the King's Scholars' pond sewer—the contents of that sewer to be received in a well constructed for the purpose, thence to be raised by steam-engine pumps, and carried by a main pipe about eleven miles in the direction of Egham, with branch pipes to the surrounding farms; the distribution of which, however, will depend much upon private arrangement. When used for irrigation, the liquid is to be discharged from one of these service pipes into the channels usually employed for that purpose; when applied to tillage land the service pipe is to be brought to some convenient distance in the field, there to communicate with a hose made of canvas, and capable of being elongated and conveyed to particular spots, from whence the water may be thrown by a jet over as extensive a surface as the pressure upon the pipes will admit—that pressure being derived from a stand-pipe about two feet in diameter, and 150 in height, the entire distribution to be conducted by the servants of the company, with a view to its proper control, aided by an adjustment at the steam-engine, to indicate the quantity of water taken at the extremities, so that the speed of the pumps may be diminished or increased accordingly.

The company expect that the farmers will find it their interest to allow it to be used exclusively for irrigation during the night and during the day by jet and otherwise, so as to equalize the supply in the 24 hours, and prevent the waste which would otherwise occur in the absence of reservoirs. Looking, however, to the difficulties that usually attend a first experiment, and to provide for extraordinary floods, means are to be adopted

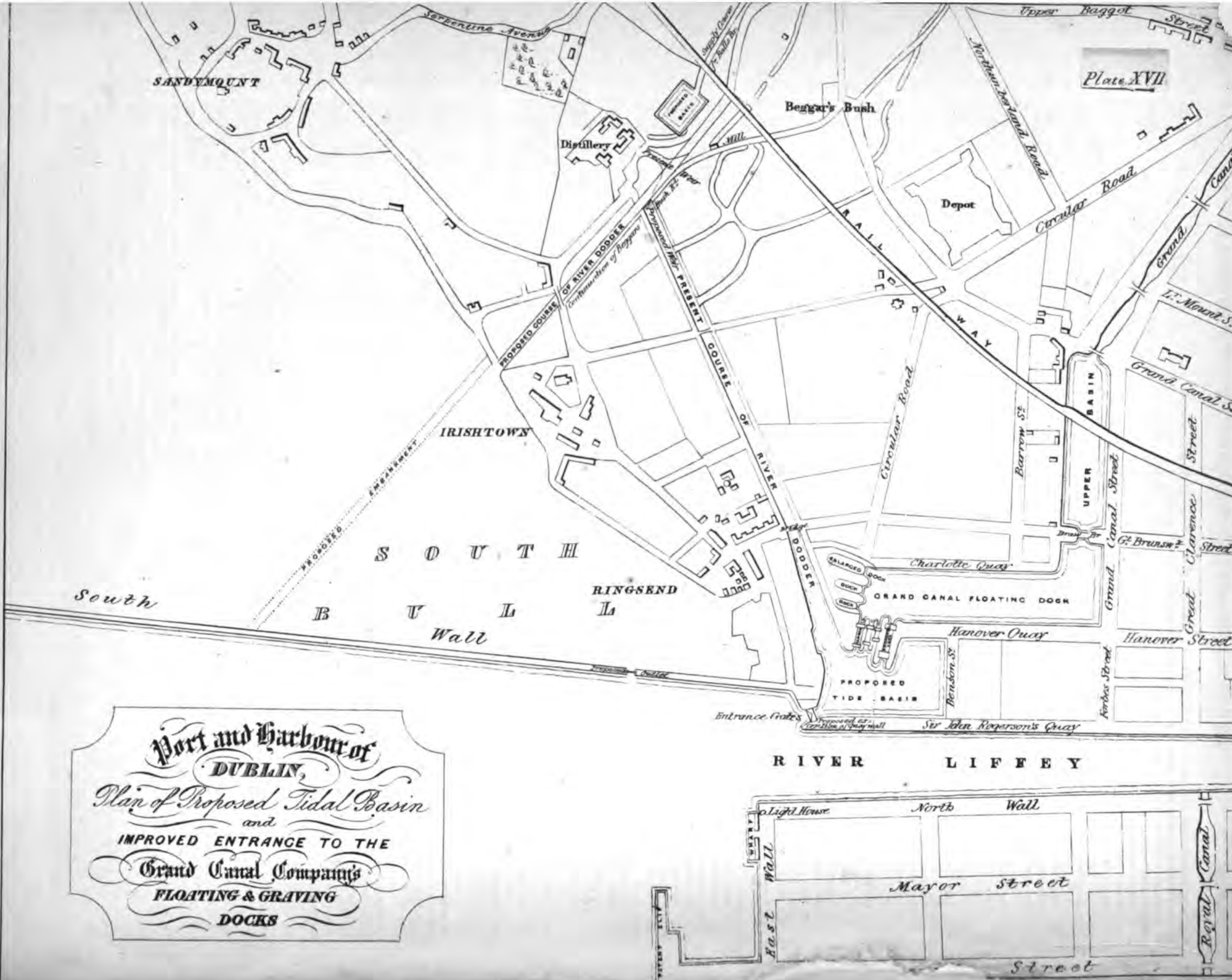


Plate XVII
Port and Harbour of
DUBLIN,
Plan of Proposed Tidal Basin
and
IMPROVED ENTRANCE TO THE
Grand Canal Company's
FLOATING & GRAVING
DOCKS
SANDYMOUNT
Serpentine Avenue
Upper Baggot Street
Beggar's Bush
Distillery
Northumberland Road
Depot
Circular Road
RAILWAY
PROPOSED COURSE OF RIVER DODDER
PRESENT COURSE OF RIVER DODDER
IRISHTOWN
RINGSEND
SOUTH BULL
PROPOSED EMBANKMENT
South Wall
Mill
Grand Canal
Lr. Mount St.
Grand Canal St.
UPPER BASIN
Barrow St.
Gt. Brunsw. Street
Great Clarence Street
Grand Canal Street
Charlotte Quay
GRAND CANAL FLOATING DOCK
Hanover Quay
Hanover Street
Forbes Street
Benson St.
PROPOSED TIDE BASIN
Entrance Gates
Sir John Rogerson's Quay
RIVER LIFFEY
Light House
North Wall
East Wall
Mayor Street
Street
Royal Canal

for allowing any surplus to flow into the Thames without going back into the sewer; at the same time that the company confidently anticipate, after the farmers shall have had experience of the value of the manure, that the demand will be greater than the supply. The supply is calculated at 60,000,000 tons annually, producing, at 2*d.* per ton, an income of 50,000*l.*, which would leave above the outlay a net profit of 13,000*l.* on an estimated expenditure of 120,000*l.* It will require 28,000 acres to consume the 60,000,000 tons, of which it is expected that two-thirds will be taken for the irrigation of meadow, and one-third for the enrichment of tillage land. As the process of pumping will be conducted in a closed building, so constructed as to carry any fœtid exhalations that may arise from the water during the short period it is exposed to the atmosphere, into the furnace of the steam engine, there to be destroyed, the committee arrived at the conclusion, not only that this station-house will be unobjectionable, but that by the proposed means the liquid will be removed in a far less offensive state than that in which it is now found, when backed in the open sewer by the high tide, and stagnating for hours together in the immediate vicinity of a thickly inhabited district, to be subsequently poured forth at low tide into the open bed of the river. The only remaining danger or inconvenience to be apprehended was from the breakage of the pipes or the ultimate distribution of the water upon the land; but as it had been clearly established in evidence, first, that sewage water is not corrosive in its nature or liable to generate explosive gases, and next that its distribution is not attended with an offensive effluvium unless in hot weather, when, owing to its rapid absorption into earth, the unpleasantness is of very short duration, the committee had no hesitation in believing that it may be as safely conveyed in iron pipes as the water of the Thames is at present by the several companies who supply the metropolis; and that in its application to the land it will be less offensive than manure in its solid state. The report contains some very interesting evidence from scientific men, supported by that of skilful farmers, and showing, that under an improved system of husbandry, by the application of the science of chemistry to that of agriculture, the soil, no matter what its nature or locality, may be rendered by many degrees more productive and more profitable. A minute chemical analysis of the sewer water of London, besides being unintelligible to the general reader, would be out of place in a mere abstract. All capacities, however, can understand the result, as given in the evidence of Mr. Miller, Professor of Chemistry in King's College. He found in it considerable portions of ammoniacal salts, alkaline salts, and earthy phosphates, substances which are found in the soil in only small quantities, but which are nevertheless absolutely essential to the maintenance of vegetable life. These ingredients are principally derived from the ashes of our bodies, resulting from the food we have digested; and as we have received them either directly from plants, or indirectly through animals from plants, it is evident they must be the food of plants, and that plants receive them from the soil, which they gradually exhaust. Mr. Miller stated also this curious fact—that the money value of those ingredients as poured into the Thames from the King's Scholar's Pond Sewer alone, assuming that the quantity falling from that sewer is 12,000 tons a day, amounts to no less than 62*l.* every twenty-four hours, or 22,630*l.* a year. The report likewise contains much useful information derived from the experiments of practical men in the application of sewage water to land, showing in all instances that it possesses a much greater fertilising power than either guano or the ordinary farm-yard manure. A Mr. Thompson, of Clitheroe, in Lancashire, on applying eight tons of it to one acre, fifteen tons of common manure to another, and three cwt. of guano to a third, found that the grass raised by the sewage water, compared with the quantity produced in the other two cases, was as fifteen tons against eight. The Duke of Portland is stated by means of the sewage water of Mansfield, and a cost of 30*l.* an acre for bringing the land into a proper form for irrigation, to have raised its value from 4*s.* 6*d.* to 14*l.* an acre. Mr. Dickinson, an extensive keeper of horses, by the use of liquid manure derived therefrom, got ten crops of Italian rye grass in twelve months, some of them more than three feet high, out of land (on his farm at Willesden, near London), which a Lincolnshire man had previously said he would not give 12*s.* an acre for, if at his own door; and which a Norfolk man declared he would not farm as a freehold. Speaking of the present year, Mr. Dickinson stated, that the first crop was cut in January, yielding more than four tons an acre, that the second gave about double that, and that the fourth, which had been cut in the month of June, had produced at least twelve tons an acre. From his calculations it appeared that one horse supplied sufficient manure for one acre; and when pressed for a direct opinion upon the subject, he replied, that he had no doubt whatever that every animal that lived, by his refuse being economised, would produce more than he could consume. This is an important fact for the agriculturists, especially at the present moment, and it is to be hoped they will not lose sight of it, but endeavour, like Mr. Dickinson, to make their land more productive, and thereby not only benefit themselves and the country, but materially serve the cause of science

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Fall of Railway Bridges, Embankments, &c. have occurred at numerous places. At Aberdeen, several arches of the inclined plane; between Linton and Dunbar, three bridges; on the Tynemouth Extension line, three yards of tunnel; on the Newbury line, several bridges; fifty yards of cutting on the Brighton and Hastings line.

PORT OF DUBLIN.

Improvements of the Grand Canal Docks at Ringsend.

(With an Engraving, Plate XVII.)

Among the chief commercial interests of the city of Dublin is the extensive trade of the Shannon and the Grand Canal. The enlargement of the canal docks has therefore been long considered a subject of great mercantile importance, and from a Report of Sir John Macneill, now before us, there appears every probability of this great improvement being speedily effected.

The principal features of the undertaking are the formation of a new Tida basin, the diversion of the river Dodder and the construction of a new entrance to the Floating and Graving Docks. The task of preparing a design for effecting these objects has been confided to Mr. McMullen, and has been performed in the most simple and satisfactory manner. The plan proposed by Mr. McMullen is made the subject of a warm eulogium in Sir J. Macneill's report, which speaks of its extreme "simplicity," and the "extraordinary facilities which every where exist for carrying it into execution." The following extracts from the Report, and a reference to the Plate XVII. will sufficiently explain the nature of the proposed improvement.

It is impossible to cast the eye over your Company's splendid Floating Basin, covering, as I understand, twenty-five statute acres, with a depth of water which I find is now steadily maintained at 18 feet or thereabouts, without a feeling of great regret, that facilities, such as are thus afforded, both for the foreign and coasting trade of the port of Dublin, and the important adjacent districts, should not be as available for the advantage of that trade as they unquestionably can be rendered; and for the accomplishment of this most desirable object, I freely admit that I have seen no project or plan at all comparable to that now before me, either as to the extent of the advantages which it is calculated to secure, or the comparatively small cost at which it is capable of being executed.

Of the several operations which the carrying out of the project involves, there is none the necessity for which is so manifest, or the cost of which would be so trifling, compared with its importance, as the turning out of the Dodder upon the South Bull. An enormous deposit is carried down and lodged in the channel opposite the entrance to the docks. The dredging out of the narrow, and as yet quite inadequate channel, forming the approach to Camden and Buckingham Locks, and of that portion of the river immediately opposite, has, this year, as I am informed, occupied the two powerful steam dredgers of the Ballast Corporation, for a period of about two months, at an expense which cannot but be very heavy, and which must recur annually, and inevitably after the winter floods, as long as the river is allowed to remain in its present course. The necessity for an improvement so obvious has been long felt. I find that it was recommended by the Irish House of Commons on various occasions, and attached to their proceedings of the date of 26th February, 1785, there is a ground plan of the new course into which it was proposed the river should then be turned, which scarcely at all differs from that laid down in the present plan. And this was further followed up by the enactment contained in the act, creating the present Ballast Corporation, by which the directors of that corporation are authorized to carry out and complete the measure. In accomplishing it, there is no actual necessity for the removal of the present weir, although this would render the results more useful to the adjacent grounds, and in this case a supply of water to the neighbourhood could be readily obtained from the river above Ball's bridge, and a reservoir formed on the site of the mill-pond of the old distillery, as sketched on the plan. I have examined the ground which it is proposed the new course should occupy. In length it is about 600 yards.

An apprehension has, as I am informed, been expressed in some quarter, assumed to be entitled to attention, and in this way brought under your notice, to the effect that the sand, carried down by the river, and which, in the event of the proposed change of its course, would be deposited on the south strand, might possibly be drifted across the Bay towards the entrance of Kingstown harbour, and produce inconvenience or obstruction there. Such a result I consider to be altogether out of the question, and the anticipated suggestion of it, destitute of the slightest rational foundation.

In turning to the plan for the formation of the Tidal Basin, it is impossible not to be struck with the fact, and it is one of manifest importance, namely, how much of the work has been already done, and how little, for the realization of the whole project, remains to be accomplished? while of this latter, the entire is of the plainest, every-day character, and quite free from any thing which could be regarded as an engineering difficulty. The whole is in fact comprised in the excavation of the ground, the extension of the present south quay wall, the lining of the interior with cut-stone facing, well puddled, and the construction of the entrance gates. The proposed Lock for the admission of steamers of the largest class to the upper basin does not appear so indispensable to the successful working of the plan, as to call for its being immediately undertaken. It may be prudent to wait the result of the trials of the screw propeller now in progress, and in the meanwhile the outer basin will afford a very large amount of accommodation to the ordinary class of paddle steamers. In reference to the excavation of the basin, it is well deserving of notice, that the ground inside of the Queen's and the other adjacent timber yards, is greatly below the level of the quays, and of high water, and that the material excavated may be not only very beneficially and usefully deposited in these yards, but that the close proximity of such a place of deposit will be a source of considerable economy in carrying out this part of the work.

As regards the convenience of the shipping of the port, the portion of the project which, beyond every other, would seem to recommend it to public favour and approval, is the position of the entrance to the Tidal Basin, in a right line with the direction of the River; a fact so manifestly important, and calculated to afford facilities both for ingress and egress, so obvious, that it is quite unnecessary to enlarge upon it.

It will be necessary to continue the main sewer, by which the water is at present discharged from the Gravin Docks, at a sufficient depth under the bed of the Dodder, to the opposite or Ringsend side of it to be carried in a direction parallel with the bank of the river down to the Liffey, east of the Dock entrance, there to discharge at the level of low water spring-tides, and which sewer can also be made use of for unwatering the low ground, south of the docks.

The last in order of the various points to which, in considering the whole of this question, my attention has been drawn, is one which, especially in an engineering point of view, I regard as not only most important, but highly interesting. It is indicated on Mr. M'Mullen's plan, but not on a scale, in my mind, sufficiently extensive to accomplish the object which I should contemplate. I allude to the Break-water which he proposes should be formed from the point at which, by the new course, the Dodder would be discharged upon the South Bull, across to the great South Wall, with an opening in the latter for the out-flow of the water retained within this barrier at each ebb of the tide, and through which opening it would consequently be discharged into the channel of the river, which forms the sailing course, and where it would necessarily act as a scour, in regard to that important portion of the entrance to the harbour. Of the soundness of the principle, and the beneficial effect which would in this way be produced, there can be no doubt; but to render it as effective as the general condition of this portion of the sailing course would appear to require, it must, in my opinion, be carried out on a considerably more extensive scale: the mound to be raised commencing, in any case, as far eastward as the Pigeon House, and terminating at or near to the Martello Tower, on the Sandymount strand. It does not seem necessary that the proposed barrier or mound should be raised to any considerable height, as the effective action of the Scour would occur as the ebb tide approaches to low water. I think that a sufficient mound or barrier could be formed, of such a height as I contemplate, from the heavy clay and gravel, of which the strand in this part of the bay consists, at a very moderate expense. The bridge to form the opening in the wall for the efflux of the water, of whatever number of arches it may consist, should be at the least, from 200 to 300 feet wide. Of the cost of this part of the work I have not framed nor submitted any estimate. It is plain, however, that, with reference to the importance of carrying out such a project, it would be comparatively speaking but inconsiderable.

A glance at the present state of the Bay shows that, as far eastward as the Poolbeg Light, it is divided by the great south wall into two nearly equal portions. The effect of the great north wall, has been to cause the ebb water of the northern division to act upon the bar, and in this respect it abundantly answered the expectations entertained by its projectors. If, in addition to the important and valuable action so obtained from the northern section of the Bay upon the Bar, it shall be practicable, in a similar way, to empound the Tidal Waters of the southern division of it, and, as I confidently contemplate, to produce from their efflux a corresponding beneficial deepening action upon the continuation of the bed of the river, forming the entrance channel to the inner harbour, a result will have been obtained of the most decisive character, not alone as regards facilities of access, and the safety of the shipping frequenting the port, but calculated also to diminish, to a very large extent, the cost annually incurred in dredging out of this channel the vast quantity of silt and mud, which under present circumstances is, and must continue to be deposited in it.

Estimate of the proposed Course of the River Dodder through Irishtown.

Purchase of Land	2,245	0	0
Earthwork in excavation. cube yards, 21,368 at 9d. per yard	801	6	0
Sea-pitching at Irishtown, ditto 508 ,, 6d. ditto	152	8	0
Bridge at Irishtown, with approaches, &c.	1,975	4	10
	£5,173	18	10
Add 10 per cent. for contingencies	517	7	10
Total amount ..	£5,691	6	8

THE WYATT WELLINGTON.

Sir—On the appearance of Professor Cockerell's Letter in the "Times," I addressed one to that paper to say that the objections urged by him against the equestrian statue of the Duke being placed transversely across the arch, instead of in the axis of the archway itself, were brought forward nearly eight years ago in a work where it might be supposed they could hardly have escaped the notice of architects, at least not of the architect of the structure, since they were made in the letter-press account given of it in the second edition of the "Public Buildings of London," where that arch forms one of the new subjects added to the original work, and is illustrated by a ground-plan and elevation. Yet, although the "Times" appeared to take very great interest in the affair of the statue, having brought it forward more than once in its leader, the Editor did not think proper either to insert or to offer any reason for rejecting my letter; and as it had then become too late in the month to send to your Journal, my comments on the matter could not possibly appear earlier in it than they do.

The whole affair is a curious one from first to last, and exemplifies more forcibly than favourably the manner in which matters of the kind are managed in this country—the crooked policy, and that species of astuteness which is called cunning, that are brought to bear upon them. No deference has been paid to public opinion, for concealment has, as far as practicable, been studiously kept up, as if the public possessed no right of opinion, and therefore the expression of it in any shape, was no better than unwarrantable interference. Would it then be more becoming in the public to observe the neutrality of silence upon such occasions—to manifest an indifference that would be praiseworthy because not at all troublesome? If so, those are taking a very wrong course indeed who are advocating and seeking to diffuse among the whole community a more familiar acquaintance with art generally, and a more enlightened appreciation of it. On one side, the public are told that they ought to acquire a taste for Art, to take a lively interest in it, and also to watch over its interests; on the other they are told—at least given very significantly to understand, that they have properly no voice in such matters, or their voice no authority, and it may therefore be disregarded as idle clamour.

Those concerned in the management of public works—some people call them *jobs*—will perhaps say that they do not dispute our right of judgment and of freely expressing it; all that they request is that we should not express it prematurely, but wait until the work be completed, when it can be judged of fairly. This is very plausible; it seems at first sight, perfectly reasonable, but only at first sight, for when looked at more closely, it will be found to mean that the public ought to be kept as long as possible in the dark as to what is going on, and be hindered from judging rashly and prematurely by being debarred from forming more than random conjectures and vague surmises, until not only the work, but the mischief that might have been guarded against by a little *premature* criticism, is completed. The most *ill-timed* criticism of all is surely that which comes too late to be of service, because unless it be the bearer of commendation, it brings only reproach and regret,—warning, indeed, for the future, but warning just as useless it seems as mere regret itself. We have had our warnings—our dearly-bought experiences, and much we profit by them. There is Buckingham Palace, which after costing about a million in the first instance—how much more has been expended upon it since it was occupied is not so well-known—is spoken of only for universal scorn and derision as a positive "disgrace to the nation,"—which as far as the nation is concerned is flagrantly unjust, because the nation had no other hand in the matter than paying for that costly piece of architectural brummagem. It was not the nation that forced that precious bargain upon George IV., but just the reverse: so let the "disgrace" fall where it ought. Not but that the nation was to blame too, for its negligence and supineness in not inquiring *prematurely* what was the quality of the commodity—or the *incommodiousness* as it now turns out to be—which it would have to pay for. Nor is that unhappy edifice the only one, by very many, that has been pronounced a failure: the National Gallery is another signal instance of mismanagement; and the hackneyed idea of a mere column was adopted for the Nelson Monument, in defiance of the strong wish expressed for something less common-place. When the façade for the British Museum was begun about two years ago, no regard was paid to the demand then made, that the model should be produced for public inspection;—on the contrary, such a dogged silence preserved that a formal refusal would have been almost courtesy in comparison with it.

To what purpose then, it will perhaps be asked, is it to raise clamours of the kind when we find that they are altogether unheeded? It certainly is to very little purpose merely to raise them, if they are dropped again almost immediately, as is generally the case, wherefore no notice is taken of them; those who might else be forced to do so, feeling pretty confident, that after the first firing the press will have exhausted its ammunition or give up the attack in despair. It is not by a furious momentary discharge, but by a constant and well-directed one kept up determinedly that we can reasonably expect to carry the point on such occasion. Would it not be equal folly and presumption on the part of any individual writer—of myself, for instance,—to imagine he can effect any thing, unless he be publicly seconded by others? But people seem to think that if remonstrances are found to produce no immediate effect, it can be of no use to continue, or to bring fresh detachments of them into the field. On the contrary, when a harder blow than usual has been given,—one that *ought* to stagger and confound, instead of following it up by another still harder, they draw back as if in alarm for the consequences of their own might and valour.

Professor Cockerell appears to be one of the considerate, for he not only considered a very long while before he could prevail upon himself to step forward and protest against the Wellington statue being placed on the Arch, but, lest his interference should derange matters and upset the scheme was so considerate as to keep silence till almost the very last moment, when it was hardly possible that his advice should be followed without great inconvenience; whereby he himself furnished the committee with a good excuse for not adopting it, conveniently reserving to himself the power of saying or fancying that it would have been adopted, had it not unluckily come just too late; still, even the convenience has its awkwardness, for some people are so inconsiderate that they will be apt to ask why he held back till the very last moment. They may also feel a little astonishment at the complete silence observed by the other architectural Professors. Are we to understand it to be equivalent to consent—acquiescence in and approval of what has been so virulently condemned? If so they have been wanting in generosity towards the authors and perpetrators of the scheme. On the other hand, if they agree with Professor Cockerell, they might, without impropriety, have openly sided with him. Or shall we attribute their silence to indifference?—or if not exactly to indifference to that discretion which prompts steady people to cross over the way, or turn into another street where they see a fray going forward? Even if it was no affair of theirs, and they were fearful that the offering any opinion might be considered busy-body officiousness, it did concern Mr. D. Burton, and as he did not choose to appeal to the public when he was sure that the general opinion would have strongly supported him, it may very fairly be questioned whether he cares at all about what has been done to his building. The inference may not be very charitable, nor particularly flattering to him, but it is certainly a very natural one.

After all, however, his Arch does not suffer more than another building does, viz, the house over the way, which now looks more insignificant and undignified than ever. Strange! that of two Wyatts, one thought he could not make the Duke look too big, the other, his house look too little—and too *petite* in style.

L.

REGISTER OF NEW PATENTS.

If additional information be required respecting any patent, it may be obtained at the office of this Journal.

BRICK AND TILE MACHINE.

Alfred Hall, of Coxsackie, in the United States of America, brickmaker, for "*certain improvements in machinery or apparatus for making, moulding, or manufacturing bricks, tiles, and other articles, from earthy or plastic materials.*"—Granted October 2, 1845; Enrolled April 2, 1846.—Reported in *Newton's London Journal.*

This invention relates to the construction of a machine as shown in the engravings, Plate XVI., for making bricks, tiles, and other articles from clay. Fig. 1 is a side view of part of a pug-mill, and the moulding apparatus. Fig. 2 is a plan, and fig. 3 a vertical section through the centre of the moulding apparatus and pug-mill, and fig 4 a front view of the moulding apparatus. A is a pug-mill, set on a brick foundation B and pillar C; in the centre of the mill is a vertical shaft *b*, supported upon a step at the lower part, and at the upper part by a framing, to which is attached a beam for the application of horse-power. On the shafts are fixed a number of horizontal cutters, *c*, set radially, and at the lower end are 4 plates, *d*, set horizontally in two lines at right angles to each other, and slightly inclined from the perpendicular, they extend nearly to the sides of the mill, and are for the purpose of sweeping the clay, as the shaft rotates, into the chamber of the moulding apparatus.

The moulding apparatus consists of a chamber, D, with iron plate sides, *f*, and a cast-iron grating, *g*, for the bottom (shown separately in fig. 5), consisting of a square frame with cross bars forming as many compartments as there are bricks or tiles to be produced at one working in the mould or box, *z*, under the grating. Above the chamber is a shaft, *h*, with bearings at each end in the side plates, *f*, which carries quadrants provided with segmental racks, *i*, and the cover or pressing plate, *k*, extending the whole width of the chamber D, for the purpose of forcing the clay into the chamber through the grating *g* into the mould *z* below. *l* is another shaft with bearings in the side plates *f*, carrying 2 pinions, *m*, that take into the segmental racks *i*, and having a hand-wheel, *n*, keyed on to the end of the shaft, for giving motion to the quadrant racks. *p* is a scraper, the whole width of the chamber, fixed on a shaft with bearings at each end in the side plates *f*; this scraper is for cleaning off the clay from the segmental portion of the pressing plate *i*.

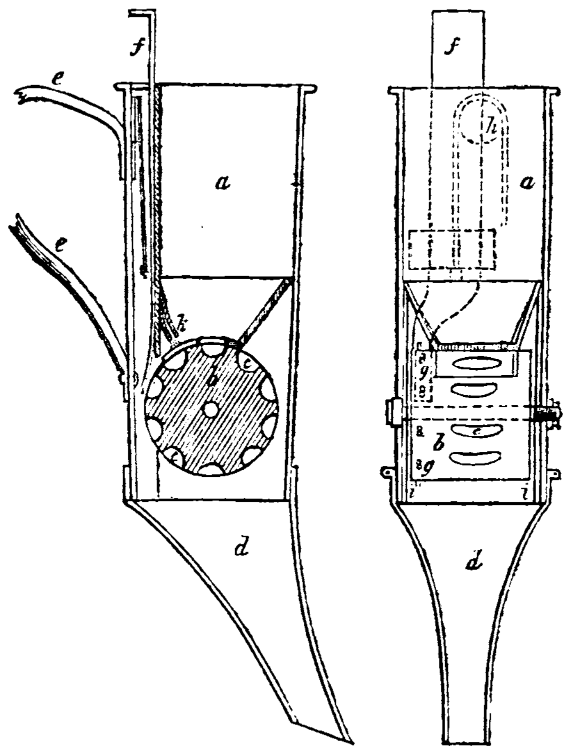
Below the chamber is the frame work, E, with an adjustable framing, F, suspended thereto by 4 pins, which carry the bearing of a horizontal shaft, q^1; shaft supports arms at each end, attached to the framing F, and also at each end a lever, q'; there is also a cross-bar, *r*, to carry the inner end of the framing, F, which is attached to and forms the cast iron tables or grating, *s*, which support the moulds, *z*. s' are rollers for carrying the mould immediately beneath the grating of the chamber. The lower parts of the framing, F, are bearings for a horizontal shaft, which carries a vibrating lever, *t*, with another lever, *u*, jointed thereto, having forked branches on the end in the form of a V, which carry a pair of guide-wheels with flanges, *w*, running in a slot made in the upper face of the framing F, and to the ends of the V lever, a cross-bar, *x*, is bolted, *y* is a lever fixed on the end of the cross-shaft for actuating the lever *t* and the parts connected therewith. and *z* are moulds which are supplied to the machine by hand as they are required.

The action of the improved machine is produced as follows:—Rotary motion being given to the vertical shaft *b*, of the pug-mill, the plates *d* will force the clay through the opening *e*, into the chamber D; and, supposing a mould to be placed upon the rollers 9, in the position shewn at fig. 3, the hand-wheel *n* is turned, which giving rotary motion to the pinions *m*, in gear with the segment-racks, will bring down the pressing plate *k*, and force the clay into the compartments of the mould. The workman then pulls down the lever *y* (at the same time letting go the hand-wheel), which action will cause the lever *t* to vibrate and draw forward the lever *u*, and with it the cross-bar *x*. This bar, guided in its course by the wheels *w*, will push forward a mould previously placed in front of it, as z^1, fig. 3, and drive that mould to the position of mould *z*, now full of clay, from under the grating *g*, in escaping from which the superfluous clay will be removed by the inner edge of the inclined side of the grating. The full mould will then arrive at the position, on the framing, of the mould z^2, from whence it is ready to be carried to the drying ground. By throwing upward the lever *y*, the bar *x* will retire to its former station, and another empty mould being placed before it, the same movement will be repeated after the mould last pushed under the grating *g* is filled with clay, as before described. If, by accident, any stone or other hard substance should get into the clay and stop the proper action of the moulding-machine, it is only necessary to depress the lever 7, on the shaft 4, which will bring down the framing a sufficient distance for the mould to be released.

The claim is, firstly, for the general arrangement of the apparatus, as described; secondly, the peculiar arrangement and construction of the knives and plates for tempering the plastic composition, and forcing it out from the pug-mill; thirdly, the construction and application of an adjustable framing for holding the moulds to receive the plastic composition, such framing being capable of instant depression, as above explained; fourthly, the arrangement of apparatus for placing the moulds successively under the grating *g*, as above described and shewn in the drawings; and lastly, the peculiar arrangement of the grating *g*, with respect to the compartments of the moulds, whereby perfect bricks, tiles, and other similar articles are produced, as above explained.

DIBBLING APPARATUS.

John Fuller, of Beacham Well, Norfolk, Farmer, for "*improvements in apparatus for sowing corn and other seeds.*"—Granted March 5, 1846; Enrolled September 5, 1846.

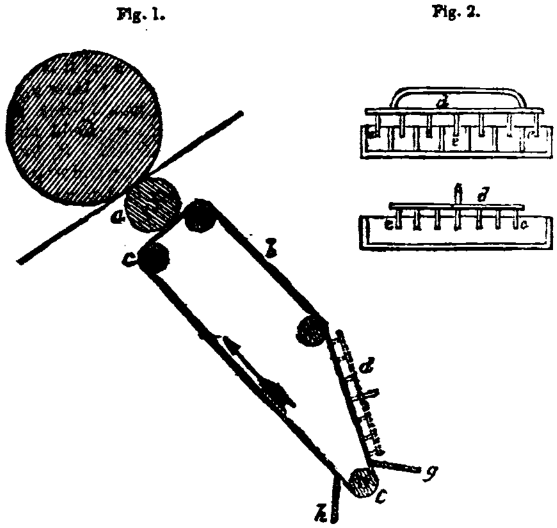


This apparatus, formed of sheet tin, is held in the hand, and used for dropping corn or other seed when dibbling, in place of the fingers. There are three different apparatus described in the specification; the annexed figures shew the application of one of them. Figs. 1 and 2 are sections of the apparatus taken transversely to each other; *a* is a chamber in which the seed is placed, *b* a roller with small recesses *c* in the circumference, of sufficient capacity to deliver the proper quantity of seed through the hopper or spout *d*; *e* is the handle, *f* a slide to be pressed down by the thumb on the top, the lower end acts upon pins *g* on the margin of the roller *b* and forces it round one division; after each pressure the slide is drawn upwards by a self acting spring *h*. *i*, *i*, are friction plates, acting against the ends of the cylinder to prevent it turning unless it be forced forward by the slide *f*, and *k* is a small brush.

PAPER STAINING.

HARROLD POTTER, of Darwen, Lancashire. Paper Manufacturer, for "*improvements in printing or staining paper.*"—Granted April 1, 1846; Enrolled September, 1846.

Fig. 1. Fig. 2.



The improvement relates to the supplying of colour to the surface roller *a*, for printing or staining paper, as shewn in the annexed engraving, fig. 1, by an endless blanket or sieve cloth *b*, stretched over 4 rollers *c*, and to move at the same surface speed as the roller *a*, in the direction shewn by the arrow. The various colours are put on the endles cloth *b*, by a hand-block *d*, fig. 2, having several rows of studs *e*, which dip into a colour-tray, containing as many compartments as there are to be different colours. For staining the paper the studs are dipped into the colours, and then placed on to the endless cloth as shewn at *d*, and the colour so placed will be spread by the cross-bar *g*, covered with woollen cloth, and pressed slightly against the endless sieve; any excess of colour will be scraped off by the bar *h*.

MANUFACTURE OF TILES.

WILLIAM BENSON, of Allerwash House, Haydon Bridge, Northumberland, Gent., for "*certain improvements in machines for the manufacture of tiles and other plastic substances.*" Granted January 15, 1846; Enrolled July 15, 1846.—Reported in *Newton's London Journal.*

The object of this invention is to manufacture tiles, pipes, and other articles, by forcing the clay or other suitable material through dies, secured to the side of a mill, similar to an ordinary pug-mill. In Plate XVI., fig. 1, is an elevation of the machine, furnished with dies for making both drain and ridge-tiles at the same operation, fig. 2 a horizontal section, and fig. 3 a vertical section. *a* is the cylinder of the mill, made of cast or wrought iron, and fastened to a cast-iron bed-plate *b*, by eight screw-bolts *c*; this bed-plate rests upon two pieces of timber *d*, *d*, about six inches square, and secured to the foundation stones by four iron screw-bolts *f*; *g* is the vertical shaft of the mill, with a bevil-wheel *h*, keyed on its upper end, and taking into the teeth of the bevil-pinion *i*, on the shaft *j*, which is driven by steam, horse, or other power. The lower end of the shaft *g* works in a brass step *k*, placed in a square box, and capable of adjustment by means of screws. The upper end of the shaft *g* works in brass bushes, fitted in the iron carriage *n*. Near the lower end of the shaft *g* there is a flange, to which is bolted a cone, *o*, formed of wood or iron. *p*, *q*, are 23 arms or knives, fixed round the shaft *g*, arranged in six planes, but there may be a greater or less number of knives and planes; for instance, a machine which is to be worked by one horse should be of smaller dimensions, and would require a less number of knives and planes, but in no case ought there to be less than three or four knives on the two lower planes, and two on each of the upper planes, and there should not be less than three or four planes of knives. In the lower plane 6 curved knives *q*, are inserted in the shaft *g*, in the second plane 6 straight knives *p*, fixed immediately above the curved ones, the third, fourth, and fifth planes 3 blades, and in the sixth plane 2 blades, all set at an angle of 45°. It is necessary that the bottom of the spindle should be conical, to facilitate the passing of the clay to the bottom of the mill, and as much as possible to the outside of the lower set of knives *q*, which, from their peculiar shape and position, press it through the dies *r*, *r'*. The dotted circles, outside the curved knives, shew the position occupied by the clay when the spindle is in motion, and as the clay descends in the mill, it is pushed towards the dies by these arms, with the assistance of the cone.

The dies *r*, *r'*, are slipped into dovetail grooves *s*, formed on the outside of the cylinder *a*, and in the bed-plate *b* (see fig. 4); the shape of the openings will necessarily vary with the form of the tiles or pipes required to be made; the dies represented in section at *r'*, are for making drain-tiles; and the die at *r* for ridge-tiles. *t*, *t*, are the tables for receiving the tiles or pipes as they come out of the dies, and are furnished with rollers *u*, *u*, which carry endless bands or webs of flannel or other suitable flexible material. In fig. 2 the tables *t*, *t*, are shewn in plan view; Nos. 1 and 3 are covered with the flexible webs, No. 2 is uncovered but with the rollers inserted, and No. 4 shews the top of the frame, without the rollers or web. *w*, *w*, are the tiles, which traverse the endless webs by the motion they receive in coming out from the cylinder *a*; and as soon as a sufficient length of tile has passed on to the endless web, it is cut off by the instrument *x*, commonly called the "horse."

In working this machine, tiles or pipes can be made on the four sides of it at the same time, or at one, two, or three sides therof, or more, if required; and different sorts of tiles or pipes can be made at the same time.

IRON MANUFACTURE.

JAMES PALMER BUDD, of Ystalyfera Iron Works, Swansea, Merchant, for "*improvements in the manufacture of iron.*"—Granted February 11, 1846; Enrolled August 11, 1846.

In burning coal, clinkers are produced and considered as refuse; these clinkers, it is proposed to apply in the manufacture of iron; they may be obtanied where large quantities of coal are burned in furnaces, or from smith's fires and waste heaps of small coal, and also from refuse ash heaps of many works which have fired and burned down, leaving a substration of clinkers near the bottoms of the heaps.

As clinkers are of a light porous nature, of small specific gravity, and contain a large proportion of earthy matter, they will be found peculiarly suitable for use in blast furnaces, with rich oxides of iron, cinders obtained in the manufacture of malleable iron, hemæteter iron ores. The clinkers when mixed with the rich oxides of iron in the blast furnace will lessen the density of the mass and allow a freer passage for the blast, and supply the proportion of earthy matters required for the perfect separation of the iron.

In charging the blast furnace the clinkers are generally to be combined with rich iron stone, iron cinder, or ore in proportion to the quality of the clinkers; if rich in iron ore a smaller quantity is required than when they are comparatively poor; the proportion of iron in the blast must be below 50 per cent—from 40 to 45 per cent is the usual proportion. If the clinkers contain less than 45 per cent. of iron, then a richer material, such as cinders of malleable iron or rich iron ore is to be used therewith. When the furnace is charged the usual fuel and fluxes are to be used with the ore and clinkers.

REVIEWS.

Elementary Text Book for Young Surveyors and Levellers. By HENRY JAMES CASTLE. Simpkin and Co. 1846.

This little work is an abridgement of a larger volume published by the same anthor, and intended principaly for the use of Students at King's College, for which Mr. Castle is the Surveying Professor. The book commences in the usual way with a few useful geometrical problems and theorems, some examples of mensuration, the description and use of various surveying instruments, specimens of field book and general instructions for land surveying and levelling.

The description of drawing instruments partakes too much of the old school; no surveyor now would ever dream of using the parallel protractor or scales engraved thereon, on the plea of the circular one being "too expensive." Those who desire to learn the practice of surveying, must not begrudge good instruments, for upon them of course greatly depend the accuracy of the work. The card-board protractor of Troughton and Sims, used by the Ordnance surveyors, is an excellent one for theodolite service; the centre being cut out, all the meridians or bearings are laid down with the parallel rules, without moving the protractor. This for traversing is invaluable, and particularly if all the work be contained within the circle cut out, which being 12° diameter admits of a tolerably sized plan.

The cross-staff is also described, but this, as well as the parallel protractor, is now entirely eschewed by practical surveyors, the "optical square" being an excellent substitute; it is made upon the reflective principle of the pocket sextant, but being required merely for right angles is much smaller and less expensive.

The off-set staff the author says is a "narrow slip of deal about $1\frac{1}{2} \times 1$, and generally 10 links long, divided into links; and should be furnished at one end with a small notch or hook to put the chain through hedges and be *numbered on both sides from different ends.*" This numbering on both sides is unnecessary, if the staff be divided into 10 parts, the centre having a double line: a little practice will make it perfectly familiar without the figures. The link-staff is best made of round ash, divided as above with a red hot wire, instead of painting or cutting; it should be shod with iron, and have a small hook and spike attached to the top; the diameter at bottom should be about one inch and taper to ¾ at the top, and the hook and shoe should be included in the measurement, namely, within a fraction of 6 feet 8 inches for the whole length.

The field book is likewise described in the old fashioned manner, having figures merely to the off-sets, *without* sketches. It is invariably the best way to sketch in the work on each side of the line as nearly as possible to resemble the objects to be delineated, and although it may take a little more time in the field, the labour is well spent by its assisting the memory in plotting. His system of "naming" the lines by their length, viz., "685 on 731" is confusing; it should be according to the page upon which the number is found, viz., "685, folio 47," and a circle should be made round the figures which are intended for stations. It is likewise very serviceable to the memory to surround those stations that run from, or across, the base line with a triangle, instead of a circle, which will be found to act as a useful index.

A chapter upon the reduction of customary to statute measure, and *vice versâ*, will be found useful,—

"*Reduction of Customary to Statute Measure*, and *vice versâ*.—The statute length of the perch is 16 and a half feet, but it is different in various countries of England.

In Devonshire and Somersetshire, the customary perch, that is, the local measure of the perch, is less, being but 15 feet.

In Cornwall, it is more, 18 feet; while in Lancashire, it increases to 21; and in Staffordshire and Cheshire it is as much as 24 feet.

This is a *lineal* difference. There is, also, in some counties of England, a *superficial* difference in the measure of an acre; an acre, in Wiltshire, containing only 120 square statute perches, instead of 160.

The Wiltshire customary acre is, therefore, one quarter less than the statute acre, and the rood one quarter less than the statute rood.

As property is frequently bought and sold by the customary measure of the county wherein it lies, the surveyor is often called upon to reduce it from one to the other.

Different Values of the Acre.—The number of (statute) square yards in an acre, will, of course, vary with the length of the customary perch of the county.—(An acre consisting of ten square chains or of 160 square perches.)

In the statute acre, a square perch is 272·25 square feet, and the acre, therefore, is equal to

$$272{\cdot}25 \times 160 = 43560 \text{ square feet,}$$
$$= 4880 \text{ square yards.}$$

In the acre of Devonshire or Somersetshire, as the square perch contains 15 × 15 square feet, or 225 square feet.

$$\text{the number of square feet} = 225 \times 160 = 36000$$
$$\text{and of yards} = 4000$$

In Cornwall, where the perch is 18 feet,

$$18 \times 18 = 324 \times 160 \text{ feet} = 51840 \text{ square feet.}$$
$$\text{or } 5760 \text{ square yards.}$$

The Lancashire perch is 21 feet long; the square perch, therefore, must contain 21 × 21 = 441 square feet, which will make the acre to contain 70,560 square feet, or 7840 square yards.

The customary acre in Cheshire and Staffordshire is the largest of the whole, each perch being 24 feet; the acre will consist of 24 × 24 × 160 square feet, which is equal to 92160 square feet, or 10240 square yards; while the Wiltshire acre consists only of ¾ the statute acre, or 3630 square yards.

To reduce Statute Measure to Customary, or one Customary to another.

Rule 1.—Bring the acres, roods, &c., in every case, to square perches; multiply these by the number of square feet in the given perch to bring them into square feet (a foot being the common unit of measurement of both statute and customary measure), and divide by the number of square feet in the required perch; this will bring it into perches; raise these perches to roods and acres and the result is the area in acres, roods, and perches of the customary measure required.

EXAMPLE 1.—Reduce 25 acres, 2 roods, 16 perches, statute measure, to the customary measure (Derbyshire) of 15 feet to a perch.

25A. 2R. 16P. = 4096 statute perches,

but the square feet in a statute perch = 272·25;

∴ 4096 × 272·25 = 1115136 square feet.

$$\text{Whence } \frac{1115136}{15 \times 15} = \frac{1115136 \text{ cust. perches.}}{225} = 4956 = 30\text{A. } 3\text{R. } 36\text{P.}$$

Ans. 30A. 3R. 36P. Derbyshire measure.

To bring customary into statute measure, reverse the preceding rule.

EXAMPLE 1.—How many statute acres are there in 28 acres, 3 roods, and 15 perches, of Devonshire measure?

28A. 3R. 15P. = 28·84375 Devonshire acres

if the Devonshire acre = 1; the statute acre = ·826447 statute acres,

whence 28·84375 × ·826447 = 23·8378 = 23A. 3R. 14P.

Ans. 23A. 3R. 14P.

Scotch Measure.—The acre in Scotland consists as in England of 10 square chains, (each chain divided into 100 links,) and is reckoned in acres, roods, and *falls*, which are equivalent to the English perches; 40 falls making one rood, and 4 roods one acre. The Scotch chain, however, is 8 feet longer than the English, being 74 feet instead of 66.

The acre being 10 square chains = 10 × 74² = 54760 square feet.

And as 10 square chains = 160 square perches,

$$\frac{54760 \text{ feet}}{160} = \text{one square perch;}$$

Therefore one square perch or = 342·25 square feet.

To bring English Statute Measure into Scotch.

Rule 1.—Reduce the given area into English perches, and then into square feet by multiplying by 272·25, the number of square feet in an English statute perch; divide this product by the number of square feet (342·25) there are in a Scotch fall, and you obtain the area in terms of Scotch falls, which bring back to their proper quantities in roods and acres.*

* To bring Scotch measure into English, reverse the preceding rule.

EXAMPLE 1.—Reduce 32A. 3R. 25P. English statute measure, into Scotch measure.

32A. 3R. 25P. = 5265 square perches.

272·25 × 5265 = 1433396 square feet in the given area,

And dividing by 342·25 = 4188 square falls = 26A. 0R. 28P.

Ans. 26A. 0R. 28P."

The THEODOLITE is next described with some examples of its use; then follows the CIRCUMFERENTOR, another old fashioned instrument, which, by most London surveyors, is superseded by the theodollite.

Examples are shown for laying down "the variation of the needle," but unless it can be *precisely* ascertained at the date of the survey, it is much better to omit it and show the magnetic bearing only—for inasmuch as the variation of the needle is different in different countries, it is safer to put the needle-bearing only, which answers all practical purposes. Many other hints and examples follow which may be more or less useful to the beginner.

The treatise on levelling is of the usual description, but does not give sufficient examples, omitting for instance, all mention of cross sections, that mostly puzzle the beginner. The author describes the staff-holder as "having considerable responsibility reposed in him." We advise therefore that this duty be simplified as much as possible, and in order to facilitate the most important part of it, that of keeping the staff upright, there should be attached two small spirit levels placed at right angles on the staff, one being at the back and the other on one side, about four feet high from the ground. Some levellers attach a circular bubble at the back, which answers the same purpose, also a handle for holding the staff without concealing the figures. The staff-holder should also carry a small iron tripod to place under the staff whenever used—this should not be attached to the staff, for it is requisite sometimes to leave it, whilst observations are being made with the same staff, at other plac s. It is always adviseable to level with two staves; when one only is used there is much liability to error, for should the instrument be out of adjustment or be turned it round, there is no means of again taking the back set. The bubble must always stand in the middle whenever the level is turned round or the work will not be correct. We mention this on the knowledge that many levellers neglect it, considering it of no importance so that the bubble is in the centre *when* the observation is made.

Origin and Reclamation of Peat Bog, with observations on the Construction of Roads, Railways, and Canals in Bog. By BERNARD MULLINS, C.E., *Vice-President of the Institute of Civil Engineers of Ireland, and* M. B. MULLINS, A.M., C.E. Dublin: Oldham, 1846; 8vo., pp. 48; five lithographic plates.

This treatise contains the subject of a paper read before the Institute of Civil Engineers of Ireland, and the result of long professional experience, makes its appearance opportunely at the present time, when the execution of public works in Ireland attract peculiar interest.

Many fallacies are exposed in the present work. It seems to be shown pretty clearly that bogs are the cause, not the effect, of the destruction of ancient forests; that, in fact, the accumulated vegetable matter which covers one-seventh of the area of Ireland (nearly three millions of acres) does not arise from the decay of trees, but from the bog moss, which only flourishes in comparatively cold climates, and entirely different from the vegetation of the morasses of warmer countries.

The absurdity of the recommendation in various Parliamentary Reports *not to drain too deep* is successfully shown, and the value of draining by deep drains for purposes of agriculture and also for the construction of solid foundations of roads and railways is considered at length. Messrs.

Mullins show that Smeaton and his successors have entertained erroneous views respecting works constructed in bog lands, and suggests methods which are recommended by experience and common sense. In addition to the valuable information which it contains, the work has the advantage of being written in a concise and perspicuous style.

Elements of Physics. By C. F. PESCHEL; translated from the German by E. WEST. Part II. *Imponderable Bodies.* London: Longman, 1846. 12mo. Vols. 2 and 3. Woodcuts.

The publication of the second part of this work has been hastened by the rapid sale of the first. This circumstance is a gratifying indication that the public taste for sound knowledge of physical science is on the increase. The volumes before us are similar in plan to that already reviewed (*ante* Nov. 1845), and treat of light, heat, magnetism, electricity, electro-magnetism, and magneto-electricity. Of all elementary treatises on the philosophy of what are termed "imponderable bodies" which we have examined, the present gives by far the clearest and most accurate account of the state of scientific knowledge up to the present time. The author, from national prejudices, occasionally assigns too large a share of the merit of important discoveries to the experimentalists of Germany; but even this defect has its compensating advantage, for it enables the English reader to regard science from a new point of view, and familiarises him with worthy names with which he has hitherto been little acquainted.

The tables of the tension of steam do not seem happily chosen. Southern's formula is accurate for a low pressure only, and Tredgold's is not trustworthy, except for pressures ranging between 1 and 4 atmospheres. The experiments of the French Academy apply only to very high pressures. The translator would, we think, have been justified in giving the far more complete tables in De Pambour's treatise on locomotive engines. The theory of the power of steam engines, developed in the same treatise, might have been substituted for the totally erroneous theory given in § 421 of the work before us, in which the evaporative power of the boiler is not taken as a numerical ingredient of calculation.

The number of errors is, however, exceedingly small in reference to the extent and variety of the subjects embraced. The author has, in many cases, given practical hints for the construction of apparatus and performance of experiments, deduced from his own experience: the collection of the matter contained in this treatise must have cost him much labour and research, and his efforts have been well seconded by the translator, who has produced a very perspicuous version of the original texts.

A Reply to some Observations in a Review of the Pamphlet entitled Metropolitan Bridges and Westminster Improvements, in the Civil Engineer and Architect's Journal, September, 1846. Addressed to the Editor of that Journal.

Sir Howard Douglas has written a reply to that part of our review of his pamphlet entitled "Metropolitan Bridges, &c.," in which the accuracy of some of his views respecting the stability of Hungerford Bridge is questioned. The following extracts from the "Reply" will, we trust, fairly represent the arguments brought against us: we had prepared some remarks in answer to these arguments, but are compelled to defer them till next month. The reasons for differing from Sir Howard Douglas were expressed with caution, and remain unchanged; but we have to express our acknowledgments of the very corteous spirit in which he has addressed to us the present vindications of his opinions:—

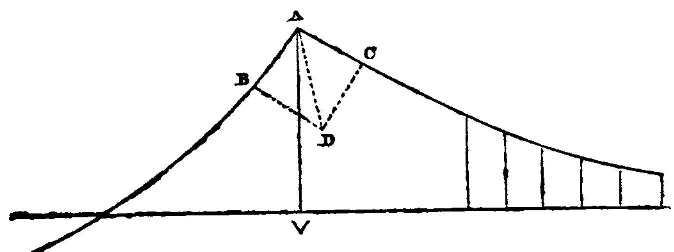
The reviewer's first objection is, that it is not confirmed by very conclusive reasoning, that the strength of the suspension chains ought to be greater than three times the strain to which they may be exposed. This can only be derived from experience. In rigid or inflexible works, this strength may be sufficient; but in suspension bridges, subject to considerable motion, and an increased strain, arising from vibration, undulation, and momentum, it is quite clear that additional strength ought to be given to those parts which support the strains; and Mr. Davies Gilbert's rule, that the strain ought not to be greater than one-sixth of the weight which the chains are capable of sustaining, appears to be well founded.........

The reviewer's next objection is, that the curve is not, as assumed, a common (simple) catenary. This observation is correct, but no error arises from considering the curve as such. In fact, it has been demonstrated by mathematicians that, when the abscissa or height of the curve bears no greater proportion to its length than that which exists in any suspension bridge which has yet been constructed, the horizontal tensions, or strains, whether the curve be a simple or a loaded catenary (a slender chain, or one from which, for example, a heavy bridge is suspended) will vary directly as the ordinate or span, and the length of the curve, and inversely as the abscissa or height: it may here be added that, when the height is small, compared with the span, the curve coincides very nearly with the common parabola (and such curve Galileo supposed it to be). In the pamphlet reviewed, the curve was assumed to be the simple catenary, merely because precise values could on that supposition be given to the tensions. But whether a catenary be simple, or whether it be considered as such a curve, modified by the weight of a road-way and suspension rods, the values of the horizontal tensions (corresponding to a or a') vary directly with the length of the chain above a given point, and with the span, or ordinate; therefore the heights, or abscissæ, being equal, the term corresponding to a' is less than that which corresponds to a, in a higher ratio than y' is less than y, which was all that it was intended to express.

The reviewer's third observation is, that, in finding the strains on the curves at the two extremities, "a formula has been applied to a case with which it has no connection:" it is added that "the value of a' is taken from the tension in a chain at its lowest point, when the lowest point is horizontal;" and it is observed that "the shorter chain, where it is attached to the abutment, is inclined to the horizon at a considerable angle," implying that there is a difference between the horizontal strains in different parts of the length of a chain suspended between two points. In this the reviewer has, however, overlooked the first principles of mechanics, respecting the properties of the catenarian curve; and it may be added, the equilibrium of an ordinary arch, since it is demonstrated by mathematicians that, both in the catenary and the equilibrated arch, the tension, estimated horizontally, at every point in the curve is the same. Hence, if a chain suspended from two fixed points in a horizontal line be in equilibrio, and if, while the chain remains fixed at one of the points, any portion be removed, the lower extremity of the portion which remains being attached to a fixed point, that portion will still be in equilibrio. The abutment chains of a suspension bridge, instead of descending at a considerable angle with the horizon to a point of the abutment much below the platform, as in Hungerford Bridge, should be fixed at points so situated that each of those chains may assume a figure precisely equal and similar to half the chain between the piers. In Hungerford Bridge, "*the chain attached to each of the abutments being shorter than half the chain between the piers,*" and "*descending to the ground at a considerable angle,*" is precisely the cause that the horizontal tensions of these chains are less than those of the chains between the piers, and that a power (represented by $(a-a')$ is constantly acting at the head of each, to draw it towards the middle of the river.

The Reviewer appears to doubt this, observing that "if the saddle were acted upon by an accelerating (qy. *moving*) force as $a-a'$, it would be set in motion;" and he probably intends to imply that the motion of the saddle would prevent the pier from being disturbed. He asserts, moreover, that "the pressure of the rollers upon the top of the pier is normal to the surfaces in contact, and is *therefore wholly vertical.*" Now, with respect to this assertion, the use of the rollers is to permit the saddles, to which the chains are attached, to shift their places, or slide, on the piers with the vibrations of the bridge; and in so far, certainly, they diminish the shaking of the piers; but, though the shaking is *diminished*, it is not removed; it exists to a great degree on account of the enormous friction, arising from the weight of the bridge, which takes place both on the saddles and piers, and when, in consequence of great strains arising from sudden accessions of weight on the bridge, the saddles are drawn to the limits of their motion on the tops of the piers, they cease to relieve the latter from the effects of such strains. This is a defect which exists in all suspension bridges; and even the ingenious expedient of the shifting saddles is incapable of removing it. The evil is, moreover, rather augmented in Hungerford Bridge, in consequence of the strains introduced by the convex figure which has been given to the platform, the height of the convexity being about four feet in the middle of the bridge.

With the suspension bridge, if A B and A C,—or to speak more mathematically, if the tangents to the curves, formed by the chains at the heads of the piers, do not make equal angles with the vertical line A V, even if the tensions of A B, A C, were equal (which is not the case in Hungerford



Bridge), the resultant of the strains at A would be in the direction of a line A D, drawn from the point at which the tangents meet, to bisect the angle B A C, and would therefore not be vertical; thus there is an excess of force acting horizontally towards the middle of the bridge, at the end of a lever whose length is equal to the height of the pier, by which the pier is continually strained, and the uniformity of pressure, on the foundations of the piers, destroyed. A very considerable error of this description exists in the Hungerford Bridge, "by the shorter chains descending at considerable angles to abutments greatly beneath the level of the floor of the bridge;" moreover, the defect, not having, so far as the author is aware, been previously noticed, he deemed it right to call the attention of practical engineers to this important circumstance, in the note, page 7, &c., of the pamphlet; and now finding that a writer in so respectable and influential a periodical as the *Civil Engineer and Architect's Journal*, asserts "that the conclusions at which the author has arrived upon this subject, are merely imaginary," assuming that notwithstanding the inequality of the angles formed by the chains with the piers, "*the pressure on the piers is wholly vertical, because it is normal to the surfaces in contact*," the author addresses to the editor a proof of the fallacy of the assumption, and trusts that, in justice to the author, as well as in consideration of the practical importance of the subject, he will not permit his Journal to sanction the repetition of so serious an error.

NOTES ON FOREIGN WORKS.

Triumphal Arch at Munich.—Besides the new portal which is to be erected at the end of the Brienner Strasse, Ludwig-street also will be adorned by a new entrance hall, which is already up to the architrave. It is to be called the *Sieges Pforte* (Arch of Victory), and has been planned after the triumphal arch of Constantine, at Rome. Its details are worked out to an astonishing nicety and beauty by the architect de Gärtner. The material used is a marble of a greenish grey colour, and its fine grain admits of a very careful elaboration. On the attic of this splendid monument there will be placed a statue of "Bavaria," mounted on a pedestal, with victories at the four corners. The models for this statuary have been made by the sculptor de Wagner, at Rome, well known by his large frieze in the Walhalla, and are to be cast in the Government brass foundry of Munich.

Latest Architectural Publications of Munich.—One of the most active and deserving authors in the Bavarian capital is G. G. Kallenbach. His work, entitled "Chronology of German Mediæval Architecture," in 48 oblong folio plates, comprises specimens from the beginning of the Romanic style, about the year 1000, to the last fading of the Germanic. It is accompanied by a short text, which, to the great advantage of the student, is placed beneath the engravings. This work is only the nearer explanation of an architectural collection of M. Kallenbach, unique in its kind, brought together by the dint of most zealous exertions, during a number of years, comprising about seventy models of mediæval buildings, ecclesiastic and private, made on the spot, after an accurate survey of the originals, and finished in their most minute details. They are made to one scale, which much enhances their value. Another publication by the same artist, entitled "Album of Mediæval Art," contains copies of the remains of mediæval sculpture in its relation to architecture and all its subordinate branches; most faithfully copied after the originals—and which is intended to dissuade the artisan from a mere repetition of machine-made models, and induce him to the study of real art originals.—Professor E. Metzger is the author of a work of great importance for the technical parts of buildings, entitled "Doctrine of Architectural Construction." It will contain 200 plates of geometrical plans, with a concise, yet comprehensive text, printed beneath the plates (a plan worthy of general imitation). The first part will treat of the different methods of construction in stone, iron, and wood; the second, of their practical adaptation to the different styles and forms of buildings, as derived from the study of architectural structures.—The Government architects of Munich continue to publish the works, with the execution of which they are intrusted. Amongst them is M. de Gärtner's work on the Royal Library and Record Office in Ludwig Street, containing, on the 20 plates hitherto published (some splendidly coloured), the different elevations, ground plans, and longitudinal and transverse sections of this splendid and extensive structure; and also the detail of the ornaments, and a view of the fine staircase supported by columns, which unites the fronts of the two buildings.—The first part of M. Lange's (the royal building counsellor of Greece) "Works of high Architecture" (*höherer Baukunst*), contains the plans for a royal residence, which was exhibited at the last Munich Art Exhibition. The same work will contain M. Lange's plans for the completion of the Munich *Frauenkirche*, which has to lose its characteristic, though unhandsome, octagonal cupola, instead of which a Gothic spire is to be raised.—Building-inspector Anger has published a work on the remarkable private buildings of the Bavarian capital, and such as serve for public and benevolent purposes.—To crown this, even the pupils of the architectural section of the Munich Academy of Fine Arts, publish the plans, made by them according to the programme of the Academy.

Academy of Sciences, Paris.—M. Person made some experiments for determining the necessary heat for fusing alloys of metals, and thinks that it is possible to determine that point, from the knowledge of the temperature which each of the component metals requires for the same process. The solution of this problem confirms perfectly the results which M. Person had drawn from his experiments on fusion—viz., the law that the latent heat of the fusion is given by the formula $(160 + f)\ d = l$.—M. Walchner announced to the Academy a most curious fact, that copper and arsenic were to be met with in *all substances and bodies*—in every sort of iron, in mineral waters, and even in meteoric stones. M. Flandin said he had analyzed the mineral waters of Passy, but had not found even a trace of copper or arsenic, either in following the procedure of M. Walchner or that of Marsh. More important is what M. Walchner says on the copper and arsenic contents of the soil of burial grounds. It has been a hitherto unresolved question whether the contents of these substances in the bodies of poisoned persons were entirely ascribable to that cause, or to the *natural* contents of the soil surrounding them. He had found both substances in the soil of cemeteries, but in very minute proportions, and he has collected a number of specimens of these soils.—M. Pierre submitted to the Society his experiments on the dilitation of fluids. The author divides liquids into two categories, and these again into nine groups. The first division comprises the bodies composed of chloride of bromine and one simple element—phosphorus, arsenic, tin, titanium, and silicium. The second category comprises the compositions of chlorine, iodine, or bromine, with any compound element, ethyle or methyle. The law which results from these experiments is this—two fluids formed by the combination of any common with any isometric element, follow (from the point of their respective temperatures of ebullition) very different degrees of contraction; or, in other terms, equal volumes of liquids thus constituted, considered at their respective temperatures of ebullition, will not preserve that equality at degrees equidistant from their temperature of ebullition. The difference, in most cases, is considerable.—M. Blanquard Evrard has forwarded to the Society two samples of photography on paper, obtained by an especial process. The samples surpass everything hitherto seen, even those of M. Bayard.

Prague and Dresden Railway.—This huge undertaking occupies alone, in the neighbourhood of the former city, 3,000 workmen, and the greatest difficulties to be overcome are from the Prague terminus to Kralup, a distance of about 16 miles. The viaduct from the terminus north to Karolinenthal and Bubna will be 580 cubits long, with 85 arches,—certainly one of the largest works hitherto accomplished in Austria. There are three minor water-courses of the Moldau river, a branch between two islands, and the main branch, which must be bridged over. A number of bridges are required to pass the numerous water-courses and islands. The bridge over the main arm will be 535 feet long, and consist of 5 arches. The arches of the main bridges will have a span of 78 feet in the clear, and form a segment, the height equal to one-sixth of the span, and are to be built of granite. The quantity of granite and sandstone to be conveyed by land and water is astonishing, some of the blocks weighing between six and seven tons. The expenses of this part of the line alone are calculated at $1\frac{1}{2}$ million of florins. There will be a small terminus in the Baumgarten (a place of public resort two miles from Prague), which will afford the humbler classes the advantages of country air at a merely nominal price.

Berlin Bresslau Railway.—This most important undertaking has lately been completed, and is open for traffic. The distance of $47\frac{7}{10}$ German miles (nearly 200 English) is performed in 18 hours, including stoppage for dinner, and thus a journey, which even Frederick the Great could never perform in less than 36 hours, is made in a few hours at a trifling expense. The chief works of the line are some very long and costly embankments—for instance, that at Frankfort-on-the-Oder, 100 feet high. The great viaduct of Gorlitz, over the Neisse, does not lay on the main, but a branch, line, connecting the lower Silesian and the Saxon-Silesian. Its length is 1500′, the height of the arches 122′ above the level of the river, and the foundations of the arches are 40′ lower, making a total of 162′. It has cost between 600,000 and 700,000 dollars, and Europe does not yet possess a work of equal magnitude. The viaduct over the Bober at Bresslau is an equally imposing structure. It is 1550′ long, and has 35 arches of a height of 76′ built of blocks of white grit. This is the longest line in the North of Germany, under the same administration. It is the more important, as being laid out afar from the hitherto commercial road, or the valley of the Oder; it passes a tract of land hitherto little connected with industry and commerce. The renting of this huge line is a matter hitherto unascertainable, which costs 18,000,000 dollars—400,000 dollars per German mile. A great drawback is that this line has only one line of rails, by which much delay and trouble are occasioned.

Prague, Austria. Sculptures.—Excavations of the Archeological Committee of the Bohemian Museum.—M. Veith, a large proprietor in Bohemia, has resolved on the curious, though praiseworthy, plan, of erecting a national Walhalla at his own expense. Professor Schwanthaler is the artist entrusted with the execution of the statues, of which twelve are ready in small models, and six in a size above life. Ready for casting are the statues of Kings Ottakar II. and George of Padiebra (the latter a sort of Bohemian Cromwell), and of Elizabeth, wife of King John of Luxembourg.—M. Max, the sculptor, is also executing some large marble statues for public establishments.—M. Raphael has made the bust of Mozart for the public library, and of Dr. Krombholz, the great physician, for the University.—Parson M. Krolmus has been successful in his excavations of heathen tumuli, hitherto very scarce in that country. He has found in the Scharka, near Prague, two stone sacrificial tables, several well preserved cinereal vases, bronzes, &c. Another heathen sepulchral ground has also been found on excavating for the Dresden railway, near Prague.

Australian Mines.—The wages of a good miner in the Borraborra lead-works, in South Australia, are £170, per annum. Even those of other artizans, masons, carpenters, wheelwrights, &c., are in proportion.

Winter Garden at Berlin.—The King of Prussia has subscribed £120,000 for the erection of a covered garden in the centre of the city.

New Pinacotheca.—The King of Bavaria has just laid the first stone of the new Picture Gallery, which will contain paintings of the present century only.

NOTES OF THE MONTH.

The Royal Institute of British Architects will commence their meetings on Monday evening, November 2, at eight o'clock, at their Rooms, No. 16, Grosvenor-street, Grosvenor-square.

Menai Tubular Bridge.—The experiments have been renewed at Millwall.

Nelson Monument, Trafalgar Square.—The proverb "a joke is a joke" has its exceptions, and the Nelson monument is one of them. The man and the boy renewed their operations upon this elegant structure a few weeks ago, but now seem to have again given them up in despair.

Coast Defences.—The Martello tower, between Hastings and Seaford, are being covered in with stone.

Chinese method of Boring.—The Southampton Water Committee have voted £150 for trying this method at their Artesian well.

Salford, Manchester.—A new church has been erected in the Early English style. Mr. Lane is the architect.

A New Institution of Mechanical Engineers has been formed at Birmingham for the advancement of various branches of mechanical knowledge, which do not fall within the province of the present Institution of Civil Engineers.

Cemetery at Cambridge.—Nine acres of land have been selected, and will probably be allotted in separate portions to each of the 13 parishes.

The South Devon Railway.—The sea wall has again been greatly injured by the wind and waves.

Public Message Delivery Company.—Of the schemes of the day, one of the most curious is a proposition to establish electro-telegraphic communication between numerous stations in every part of London, for the conveyance of messages at a low charge.

The Baths and Wash-houses in Manchester since they were opened in September have been attended by 3,000 persons.

New Dock at Honfleur.—The greater part of the wall has been destroyed by the water getting between it and the earth.

Lord Rosse's Telescope.—The report that an attempt had been made to injure this instrument has been formally contradicted.

Gold in Australia.—A valuable auriferous vein has been discovered in one of the copper mines, and the shares have risen 900 per cent.

The Wellington Statue.—Lord Morpeth has addressed a circular to all the Royal Academicians, requesting their opinion respecting the present position of the statue on the arch.

St. Michael's Ottery has been consecrated. The style is Early English; the architect Mr. Wollaston.

St. Alkmund, Derby.—This new parish church is built entirely of stone, in the late decorated style. The spire rises 112 feet above the tower, which is 92 feet high. Mr. Stevens, of Derby, is the architect.

City Improvements.—The Court of Common Council have agreed to a report, presented by Mr. R. L. Jones, recommending the formation of a new street from King William-street to the south side of St. Paul's Churchyard.

Collision of the Prometheus at London Bridge.—Propeller vessels have been very unfortunate of late. The Irish steamer Prometheus, during the month, has suffered severely, by being carried against an abutment of London Bridge. The screw propeller was unable to resist the force of the tide, which was running very strong; the stern bulwarks were crushed in, and the masts and funnel swept away.

Gun Cotton.—There are numerous claimants of this invention. Dr. Otto, Professor of chemistry in Brunswick, states, in the *Hanoverian Gazette*, that he has invented an exploding cotton, independently of Schonbein and Bœttger. His preparation, which was suggested by an observation of Pelouze, in his Journal of Chemistry (Vol. I., page 126), consists in immersing well-cleaned cotton in highly-concentrated nitric acid for half a minute, and instantly afterwards soaking it in water, which must be constantly renewed, in order to effectually free the cotton from the acid. The preparation, when dried, is ready for use. It may be exploded with a hammer on an anvil, but is capable of being rammed in a gun, in the ordinary way, without danger. M. Morel, an engineer at Paris, has recently exhibited before General Gourgaud, President of the Committee of Artillery, a fulminating cotton, which may be burnt on the hand without causing pain. It leaves little residue in a fowling-piece, and is nearly noiseless. M. Chodsko, a Polish refugee, has exhibited another fulminating cotton, which resembles the last, except in that it leaves a residue in the fowling-piece. The materials prepared by M. Morel and M. Chodsko both ignite by a blow of iron upon iron, but not of iron upon wood. The English Government have instituted experiments with Schonbein's gun cotton, which have been attended with success.

The Drainage of Haarlem Lake is to be continued by three enormous steam engines, which are to complete the work in 13 months. The Cornish engine already at work discharges a million tons of water daily.

The Great Britain.—This luckless vessel still remains a-ground on the Irish coast. She is to be protected by a floating breakwater; and the last accounts state, that an attempt will be made to rescue her by the method of flotation. Why was not this plan adopted in the first instance, instead of the violent experiment of dragging her off by main force? Had the steam tugs sent to the aid of this vessel reached her, and succeeded in drawing her into deep water, she would have been in danger of foundering. Mr. Marris Dinsdale has proposed a method of buoying her up by rafts, with Greenland oil casks on either side of the vessel, and connected by chains underneath it. This method was first proposed by him for the Prince Frederick, on Corton Sand.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM SEPTEMBER 24, 1846, TO OCTOBER 17, 1846.

Six Months allowed for Enrolment, unless otherwise expressed.

Thomas Bartlett Simpson, of Islington, Middlesex, gentleman, for "certain Improvements in propelling, and in machinery connected therewith."—Sealed September 24.

Albert Robert Cunningham, of Sydenham, Kent, gentleman, and Joseph Threlfall, Carter, of the same place, engineer, for "certain Improvements in the propelling carriages on railways."—October 1.

William Wild, of Salford, Lancashire, moulder, for "certain Improvements in machinery or apparatus for manufacturing barrels and other vessels of capacity."—October 2.

Peter Fairbairn, of Leeds, machine-maker, and Peter Carmichael, manager for Messrs. Baxter, Brothers, and Co., flax spinners, Dundee, for "Improvements in machinery for drawing, roving, and spinning flax, hemp, silk, and other fibrous substances."—Oct. 2.

Pierre Bryere, of Rue Boileau, Nantes, France, for "Improvements in the manufacture of boots, shoes, and clogs."—Oct. 2.

Edm. Morewood, of Steel-yard, Upper Thames-street, merchant, for "certain Improvements in machinery for separating certain fibrous substances; from seed and other extraneous masses."—Oct. 2.

William Wield, of Manchester, mechanical draughtsman, for "Improvements in certain mills for grinding, and in the manufacture of certain parts of mills."—Oct. 2.

Charles Marie Fouillet, engineer, of Paris, for "Improvements in railways."—Oct. 2.

Samuel Holdsworth, of Norwood, Surrey, gentleman, for "certain Improvements in apparatus to be applied to railway carriages, to prevent accidents thereon."—Oct. 2.

William Farthing, of the town and borough of Kingston-upon-Hull, for "certain Improvements in the manufacture of glass."—Oct. 8.

Robert Wilson, of Woodhouses, Lancaster, weaver, for "certain Improvements in looms for weaving velvets and other piled goods; and in the machinery or apparatus for cutting the pile or nap of the same."—Oct. 8.

Samuel Heseltine, jun., of Bromley, in the county of Middlesex, engineer, for "certain Improvements in the construction of lamps to burn oil."—Oct. 8.

John Warburton, of Kearsley, Lancaster, tin-smith, for "certain Improvements in machinery or apparatus, for preparing, slubbing, and roving cotton wool, and other fibrous materials."—Oct. 8.

William Fairbairn, of Manchester, in the county Palatine of Lancaster, civil engineer, for "Improvements in the construction of iron beams for the erection of bridges and other structures."—Oct. 8.

Francis Naider, of Cheapside, warehouseman, for "Improvements in the manufacture of gloves."—Oct. 8.

Marcel Tean Milon, of 27, Rue Fronches, Paris, gentleman, for "Improvements in making roads and ways."—Oct. 8.

John Bombley, of Sunderland, engineer, for "Improvements in capstans and windlasses."—Oct. 8.

George Lowe, of Finsbury Circus, civil engineer, for "Improvements in the manufacture of and in burning gas, and in the manufacture of fuel."—Oct. 8.

Price Struve, of Swansea, engineer, for "Improvements in railway transit, and in moving or raising weights."—Oct. 8.

John Taylor, of the Adelphi, gentleman, for "Improvements in the manufacture of explosive compounds." (A communication.)—Oct. 8.

James Farnsworth, of Sheffield, in the county of York, engineer, for "certain Improved machinery or apparatus, for "the manufacture of bricks and tiles." (A communication.)—Oct. 8.

Michel Louis Ferant, of 361, Oxford-street, gentleman, for "Improvements in treating oils." (A communication.)—Oct. 8.

George Frederick Muntz, Esq., M. P., of Ley Hall, Birmingham, for "an Improved manufacture of metal plates for sheating the bottom of ships or other vessels."—Oct. 15.

John Condie, of Glasgow, engineer, for "Improvements in machinery used in manufacturing malleable iron."—Oct. 15.

Francois Durand, engineer, and Onesiphore Pecqueur, engineer, of Paris, for "Improvements in forming leather into tubes, cylinders, switches, cases, sheaths, hats, and other articles."—Oct. 15.

James Kite, of New North Road Bridge, Hoxton, in the county of Middlesex, gentleman, for "certain Improvements in steam engine-chimneys, in furnaces and flues, in vent and exhaust pipes, and in other like smoke and air conductors, and in the machinery or apparatus connected therewith."—Oct. 15.

Arthur Millward, of Birmingham, gentleman, for "certain Improvements in producing figured surfaces, sunken and in relief."—Oct. 15.

William Palmer, of Sutton-street, Clerkenwell, manufacturer, for "Improvements in the packing of, and in the gaining, and the manufacture of products from fat, or fatty matters."—Oct. 15.

John Hornby Maw, Esq., of Hastings, Sussex, for "Improvements in the manufacture of pens."—Oct. 15.

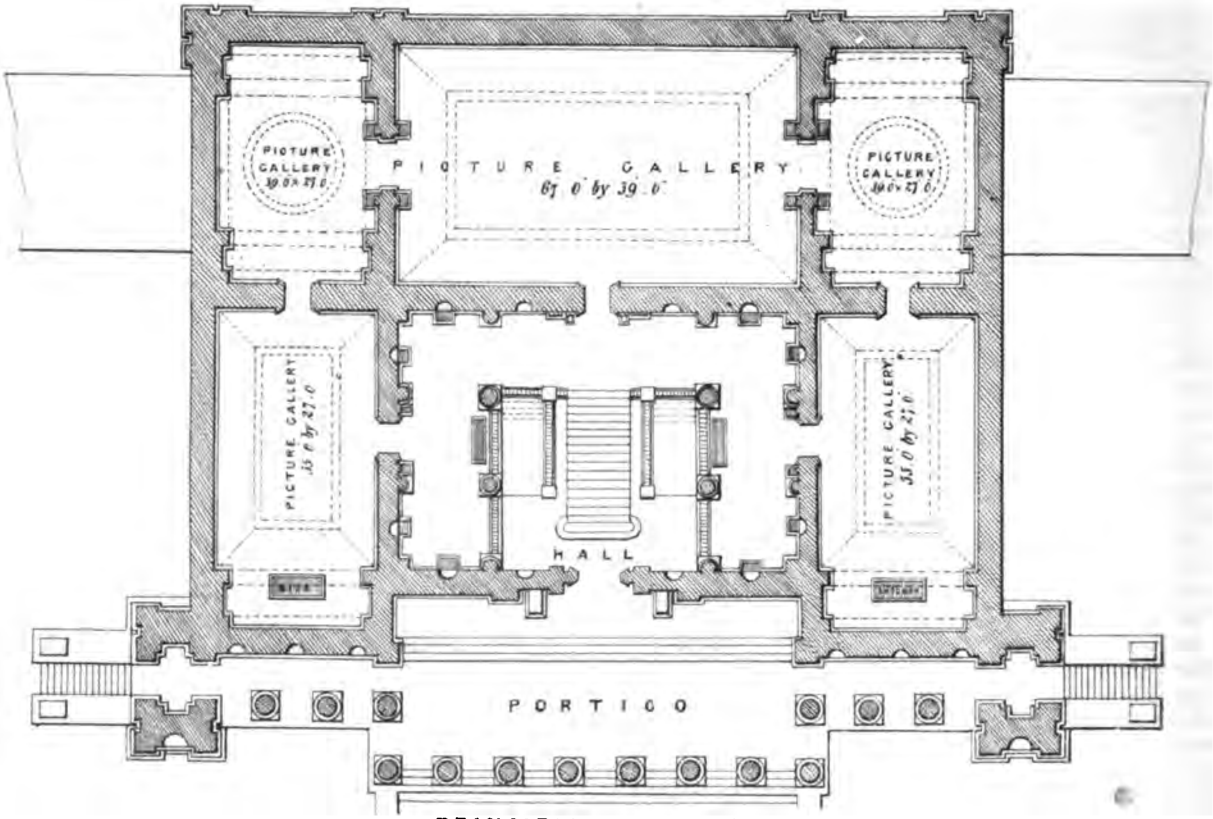
John Donkin, of Grange Road, Bermondsey, civil engineer, for "Improvements in the manufacture of paper, or in the machinery employed therewith, and in the process of bleaching paper, linen, and other manufactures in which chloride of lime is employed." (A communication.)—Oct. 15.

Ebenezer Southworth, of Chorlton-upon-Medlock, near Manchester, draper, for "certain Improvements in engines, to be worked by steam or other power, and applicable to raising and forcing water, to the propulsion of vessels, and other similar purposes."—Oct. 15.

George Winslow, of Binton Crescent, merchant, for "Improvements in machinery for manufacturing files and rasps."—Oct. 15.

John Ryan, of the Royal Polytechnic Institution, doctor of medicine and professor of chemistry, for "certain Improvements in the preservation of organic and other substances."—Oct. 17.

FITZWILLIAM MVSEVM + CAMBRIDGE.



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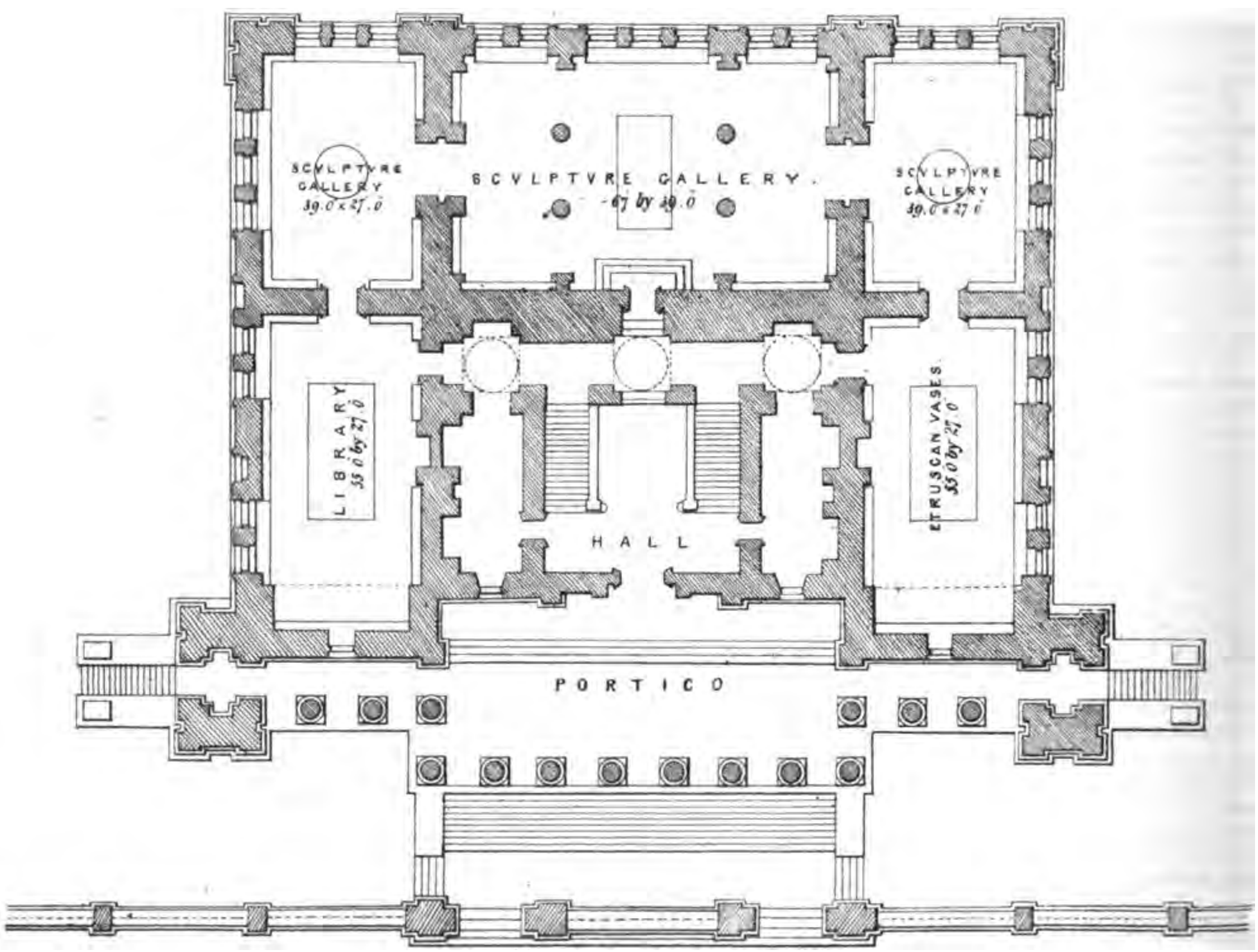


GROVND - FLOOR.

SCALE FEET.

C B.

THE INTERIOR OF THE FITZWILLIAM MUSEUM.

(With an Engraving, Plate XVIII.)

The accompanying engravings exhibit the internal arrangement of the Museum at Cambridge, of which the façade is represented in the Journal for May last, page 129. The building is occupied internally by a ground floor, and an upper or principal floor. The latter is approached by a staircase of most magnificent dimensions, leading from the hall to the sculpture gallery which extends round three sides of the hall and staircase. The architectural and sculptural ornaments of this gallery are to be of the richest and most elaborate description, and this part of the building alone will, it is estimated cost when completed £10,000. Here will be deposited the valuable collection of statues bequeathed by Earl Fitzwilliam and others. Several of these works are master-pieces of the highest class.

The principal floor contains a picture gallery 67 feet long by 39 feet broad; the height of the frieze being 27 ft., and the height of the frieze is 3 ft. 6 in., which is a correct copy of the Elgin Marbles at the British Museum, and from it springs a richly ornamented coved ceiling, which curves inwards from the sides to the centre of the apartment; above the four upper boundaries of this cove rise a vertical lanthern light, between each light are beautifully draped and winged figures, and above is a horizontal ceiling divided into compartments and most elaborately enriched with open panels, and above which are conical sky-lights; the whole height of the room from the floor to the conical sky-light is 53 feet. The floor will be of wainscot, with an inlaid border, and all round the apartment there is a scagliola dado of *Rossi broccata*, with a plinth of black and gold marble. The side picture galleries communicate with that which we have been describing, by arched openings, of which the archivolts and pilasters are decorated with various kinds of scagliola.

The ground floor of the building will be occupied by another sculpture gallery under the long and two end galleries, a library beneath one of the side galleries, and a museum of terra cottas and vases beneath the other side gallery. There is a large space under the hall and the portico, occupied by vaults, which we think might be usefully occupied as a sepulchral museum.

There appears to be some intention to remove the frieze containing a copy of the Elgin Marbles,—we most sincerely trust that this wasteful alteration will be resisted by the Senate. The frieze is thought to detract from the height of the room; we think however that when the walls are filled with paintings, the appearance in the height will be increased, and besides, it is perfectly useless to have paintings where the frieze now is, which is 27 feet from the floor—for who will be able to see them to appreciate their merit at so great a distance from the eye?

Mr. Cockerell has obtained permission to substitute real for imitative marbles in the work yet to be undertaken, and he deserves great praise for having effected this alteration. The enrichments and carving are admirably executed, from the designs of the late Mr. Basevi, by Mr. Nichols, of Grafton-street, London, whose name deserves to be recorded with great commendation; and we understand that it was Mr. Basevi's intention that all the enrichments should be picked out in gold and polychrome.

We are very desirous of seeing the brick fence wall now enclosing the ground at the back of the Museum removed, and replaced by a ballustrade similar to that at the front. This would open the back view to Peterhouse ground, and form a great improvement to the Sculpture gallery, as well as to the College grounds.

When the Museum is finished, we hope there will be a greater liberality shown to the public in allowing them to view the magnificent works of art that will adorn it, than at Oxford, where the Taylor Institute has all the gates and doors closed, and admittance is only obtained either by an introduction by a member of the University, or by *permission* of the porter. Of course, as at many other public establishments, a fee is expected.

As we were lately strolling through the College grounds of Oxford, we asked a member of the University if permission could be obtained for viewing the interior of Christchurch Cathedral, the Taylor Institute, Radcliffe Library, &c. He said he had no doubt it might by speaking to the attendants; of course they would look for a fee to be paid them for their trouble. The jealousy with which Academical and Ecclesiastical corporations guard the edifices committed to their trust is on every account to be regretted.

TRABEATE AND ARCUATE ARCHITECTURE.

SECOND ARTICLE.

In order that any branch of human knowledge may become a science, it must be founded on exact principles which distinguish it from every other science. The mere compilation of facts and opinions, however valuable and accurate in themselves, will not lead to systematic and definite results unless the facts be referred to, and the principles deduced from fundamental axioms.

The application of these considerations to architecture is very simple. Facts and dogmas innumerable relating to architecture have been recorded, but we have been too apt to estimate them according to their intrinsic, not their relative, value. Now the most valuable aid to the advancement of architecture will be the systemizing our present knowledge of it: it has hitherto been seldom regarded as a system. If every critic is to pronounce on the merits of each new edifice as it looks to *his* eye, it is obvious that his criticism will have no higher than an individual authority, that it may be disregarded by contemporaries and reversed by posterity. But if some great architectural principle be universally received by both critics and the criticized as the basis of all criticism, and if this principle be so comprehensive as to include every style of architecture, it is clear that much less will be left, than before, to the fallibility of individual judgment, and that the conclusions obtained will possess the value of being systematic.

We search in vain for any other principle than that of constructive faithfulness, which receives universal consent. There are, it is true, many architects and architectural writers, who find it their interest to resist the *application* of this principle, but none are now bold enough to deny its abstract truth. It is curious to observe how completely the general opinion has changed on this point. Now it is conceded on all hands that (theoretically at least) the decoration of an edifice ought to be the exponent of its construction—yet it is not a very long period since a doctrine the direct reverse of this was maintained. The Abbè Laugier in his *Observations sur l'architecture* (Haye 1765) condemns Pointed architecture, because edifices built in that style exhibit too evidently their mechanical structure. Some of his remarks are so directly opposed to the doctrines of the best writers of the present day, that the following version of a few sentences may be interesting, if not valuable. All the requirements of solidity (says he) consist in establishing a proper equilibrium between the arch which thrusts and the abutment which receives the thrust. Buildings, however, ought to be so constructed that no part of them may appear to exert or resist pressure.... Up to the present time we have been too much subject to this grand defect of Gothic churches; not until it was high time, did a man of genius teach us to do better. The arches of the new church of St. Genevieve are sufficiently supported, but no one can see how they are so. Nothing external announces resistance and effort. The spectator has no observations to make on the strength or weakness of the buttresses. Delivered from all anxiety on this point, he gives himself up to undisturbed contemplation of the beauty of the edifice.

Since the Abbè Laugier wrote this curious passage, architectural knowledge has so greatly increased, that it would be superfluous to show here the fallacy of his opinions. They are quoted to prove how ingeniously an error may be disguised, and to show that, in his time at least, it was admitted that the architecture subsequent to the Pointed was inconstructive. This is a most important admission, and one which many a modern practitioner would like to retract.

The importance of distinguishing between entablature and arch architecture was, we think, first insisted upon by Hope, in the invaluable Architectural Essay, which it may be presumed has by this time been carefully read by every one who professes a knowledge of architectural principles. The unsparing denunciations which Hope commenced against the showy unreal decoration employed during the last three centuries, in consequence of a confusion of the principles of trabeation and arcuation, have been admirably followed up by Professors Willis and Whewell, in the works from which we quoted in the preceding article on the present subject. Until, however, the laws which Hope suggested, and which Whewell and Willis developed, be practically applied, they remain almost barren speculations. The object set before us is not so much to elucidate existing architecture as to promote its future advancement. To this end it is requisite to see how far the laws in question tend to facilitate or impede the improvement of modern decorative construction.

It may be objected that in making architectural decoration immediately dependent on mechanical structure, we restrict the art to purely utilitarian rules. To this objection two satisfactory replies may be given. In the first place, architecture differs from other fine arts, such as painting or sculpture, in that it is not an imitative or representative art. The ends of painting and sculpture are the gratification of the taste by the representation of beautiful natural forms. But architecture is restricted by the economic purposes of the materials upon which it works. In one sense it stands alone among the fine arts, and is the noblest of them; for while the results of other arts have no value except their beauty, the results of architecture have a two-fold value—beauty and practical utility. The direct and accurate imitation of nature, which in painting or sculpture is the perfection of excellence, in architecture is simply impracticable. And therefore we come to this conclusion, that while other works of art are judged by their beauty alone, the works of architecture are to be judged not merely by their beauty, but by their FITNESS also. This consideration has been much lost sight of by those who attempt to draw analogies between the laws of architecture and those of painting: the neglect of it led, for instance, to Sir Joshua Reynolds's eulogium of the works of Vanbrugh.

But there is another strong defence against the charge of utilitarianism; which is, that the restrictions which we would lay upon architecture have been proved experimentally to be neither oppressive nor unnecessary. If it were found practically impossible to comply with this restriction without making the architecture formal and unvarying, a ground of complaint against the strictness of the rule might exist; but, in point of fact, the buildings which have displayed the greatest freedom and variety of form have been those in which the canon of constructive faithfulness has been most scrupulously obeyed. We observe, moreover, in the works of nature, from which all the principles of beauty must ultimately be derived, that the most graceful forms exhibit a wonderful fitness for the useful purposes to which they are applied. The petals of a flower are not merely beautiful ornaments; they serve effectually for the protection of the reproductive organs of the plant. The slight swelling or entasis of the stalk of corn not only renders its form graceful, but adds also to the strength necessary for its preservation. Smeaton, in constructing the Eddystone lighthouse, took for his model the trunk of the oak, which increases in breadth towards its base, meeting the ground in curved lines which experience has proved to be the most effectual for resisting the violence of storms. Lastly, anatomy teaches us that those forms and proportions of the human frame which the sculptor considers most beautiful, are the very same which best enable the several members to perform their respective functions.

Throughout the whole economy of nature this rule is maintained, of making beauty dependent upon utility. The love of the grotesque, or *bizarre* —that is, of forms without purpose—is seldom exhibited except in art. It must, therefore, be regarded as a thoroughly artificial taste—a taste, moreover, unknown in the best periods of art. To revert, therefore, to the rules of criticism, it is clear that there are two distinct ways of estimating the merits of a building,—one by the eye alone, the other by the eye and judgment. We will not be so intolerant as to assert that all architecture which satisfies the eye alone, and not the judgment also, is to be rejected; but this may be safely set down, that the beauty of such buildings is of a superficial and inferior character, and therefore undeserving of modern imitations. There are, in fact, many buildings, which, from their magnificent size and gorgeous ornament, produce a dazzling effect which gradually diminishes as the eye becomes familiarized with it. But those glorious piles, which exhibit in every part a logical fitness, derive an inner beauty, a tenfold deeper and purer eloquence, from the gratification of the judgment. They do not appeal grossly to the senses, the eye does not weary of them after the first impressions are faded; for every renewed view serves to discover new meaning, and, therefore, new delight. They satisfy the highest test of works of art—they bear studying.

Applying these considerations to what is usually considered the most magnificent edifice in London, St. Paul's Cathedral. Can the eye fail to be impressed with the depth of shadow, the proportion and variety of the lines, the graceful contour of the dome, and the apparent boldness and skill by which it has been raised at a vast height above the rest of the structure? But how does the admiration lessen when the judgment comes into exercise; when we find that this boldness in the construction of the dome exists in appearance only? This dome is not the thing it looks to be,—it is a mere juggle, an ingenious delusion of the sight. It *looks* a massive, ponderous structure, and an integral portion of the building; it *is*, in fact, a mere frame-work of wood, stuck upon the building, and not belonging to it. It appears to rest firmly upon its base; but, in reality, derives its support from hidden props and chains, and other delusive contrivances. The architect has shown vast ingenuity; but he has, in this instance, mistaken his vocation, and invaded the province of the theatrical machinist. A dome should be vaulted, resting nowhere but upon its abutments; but this sham dome is not vaulted; it is supported at every part of its concave surface. Had it been made of pasteboard, or canvas stretched on a frame, and painted, it would have looked just as well.

And the upper half of the side walls of the Cathedral are delusions also. They serve only to conceal the flying buttresses behind them. They do not add to the internal capacity of the building; and if they were removed altogether, the alteration would not be visible from the interior. On the outer or conspicuous side, little columns are affixed midway in the air—for show. Had these columns, and the walls to which they are attached, been also of painted pasteboard, their present purpose would have been answered fully as well as by more solid materials.

NOTES ON THE HYDRAULIC RAM.

The invention of this singular engine is due entirely to the genius of the celebrated Montgolfier, who made it known in 1797; the peculiar simplicity of its construction, as well of its mode of action, attracted the attention of hydraulic engineers, and of mathematicians, and in 1804, Eytelwein conducted a series of experiments upon a well digested plan, to develop the power, the proportions, and other relations requisite to its greatest efficiency. The oscillatory motion of the water in the ram, and the alternate action of the valves, indicate the physical causes which produce the effect of this machine; they are nevertheless still very far from being sufficiently understood to furnish the basis of a mathematical theory. The passive resistances, and especially those arising from the shock or blow given by the valves, interpose difficulties in affixing their value, which render any estimate of the *whole dynamic effect* almost impossible. Experiment alone can instruct us as to the *useful* effect it is capable of affording.

D'Aubuisson de Voisins has given a succinct account of the researches of Montgolfier and of Eytelwein, and these notes are chiefly derived from it.

The parts of a ram are, a pipe connecting a reservoir of water with a case or chest containing two valves—an air chamber, and a rising or supply pipe. The pipe attached to the reservoir was by Montgolfier termed the body of the ram, and the valve chest its head. Further description of the construction of the machine and of its mode of action is unnecessary here, as it may be readily found in every modern work on hydraulics.

The largest ram ever erected was put up at Mello, near Clermont sur Oise, by the inventor's son. Its principal dimensions were,

Length of body pipe . . .	108 feet.
Diameter of ditto . . .	4·3 inches.
Weight of ditto . . .	3190 lb.
Weight of head . . .	440 lb.
Contents of air chamber . . .	1½ gallons.

The tail or stop valve consisted of a horizontal metal plate pierced with seven holes, each covered by a hollow ball 1¼ inch diameter; it beats 60 strokes per minute. This ram worked under a head of water of 37 feet, discharging 31½ gallons per minute, and raising 3·85 gallons to a height of 195 feet. The ratio of the useful effect to the labouring force expended was ·653. The comparison of effect is made without taking into account the *velocity* of the motion; it is the weight of water raised to a certain height in a determinate time. Calling p'' this weight, and H'' this height, the effect is $p''\,H''$.

The corresponding force (P being the weight of fluid furnished by the stream in the same time, and H the height of the fall or head of water), is expressed by P H.—The ratio of these is consequently $\frac{p''\,H''}{P\,H}$, or since $p'' : P :: q : Q$, the ratio is $\frac{q\,H''}{Q\,H}$.

The following table shows the ratio and the effect of ordinary rams. The first experiment was made upon the ram constructed by Montgolfier himself, at his house at Paris; the second upon that erected by his son, above cited; and the others upon rams in the neighbourhood of Paris, mentioned in the Traité des Machines, p. 101.

	Height.		Water per minute.		$\frac{qH''}{QH}$	
	Fall. H.	Elevation. H''.	Expence. Q.	Delivered. q.		
1	8' 6"	52' 8	15	1·37	·57	
2	37 ·2	195 ·0	31	3·85	653	Mean ratio $qH'' : QH = ·65$.
3	34 ·9	111 ·11	18½	3·74	651	
4	3 ·3	14 11	437	59·18	·629	
5	22 ·10	190 ·10	2·86	0·22	·671	
	Ft. In.	Ft. In.	Gallons.	Gallons.		

Eytelwein made, at Berlin, 1123 experiments, gradually and successively varying the dimensions of the several parts of the hydraulic ram. He confirmed the effect produced in each case, and deduced rules for the dimensions and arrangement of the parts, suitable to the greatest effect.

The following table contains some of the experiments upon the largest of the rams he employed, in its most advantageous arrangement, viz.:—

Length of body pipe . . .	43 feet 9 inches.
Diameter of ditto . . .	0 2¼
Capacity of air chamber . .	1·94 gallons.
Area of opening of tail or escape valve .	3·74 square inches.
This area in the first experiment was raised to	6·2 square inches.

The valves were clack valves and the escape valve was placed between the air chamber and the reservoir. These experiments may have their result expressed by the following formula,

$$\frac{q\,H''}{Q\,H} = 1{\cdot}42 - {\cdot}28\sqrt{\frac{H''}{H}}$$

But as this has been deduced from experiments which in some measure refer to the maximum effect of which the water ram is capable, we may obtain the ordinary results exact enough by reducing the numerical coefficient about $\frac{1}{4}$, and we get

$$p\,H'' = 1{\cdot}2\,P\,(H - {\cdot}2\sqrt{H\,H''})$$

See D'Aubuisson, p. 503,—also Taffe, Application de la Mechanique, p. 278.

No. of Strokes per Minute.	Height in feet of				Ratio.	Gallons of water per minute.		Ratio $\frac{q\,H''}{Q\,H}$.		Ratio $\frac{Q}{q}$
	Fall H		Elevation H''		$\frac{H''}{H}$	Expended. Q	Raised. q	Experiment.	Formula.	
	'	"	'	"						
66	10	0	26	4	2·63	10·65	3·39	0·9	0·97	2·92
54	10	2	32	4	3·18	13·97	3·83	0·873	0·92	3·67
50	9	11	38	8	3·9	12·01	2·622	0·85	0·87	4·58
52	8	0	32	4	4·	8·16	1·687	0·847	0·85	4·72
45	8	9	38	8	4 4	10·85	2·09	0·845	0·84	5·2
42	7	5	38	8	5 21	9 92	1·5	0·787	0·78	6·62
36	6	0	38	8	6·5	8·89	1·05	0·754	0 71	8·62
26	4	6½	32	4	7·2	5·23	0·495	0·672	0·67	10·7
31	5	0	38	7	7·7	8·05	0 704	0 667	0·65	11·54
23	4	1	38	8	9·47	11·11	0 649	0·548	0·56	17·2
17	3	0	32	2	10·7	10·8	0·479	0·473	0·51	22·6
15	3	8	38	8	11 9	12·34	0 363	0 352	0·45	33·8
14	2	6	38	8	15·5	11·95	0 22	0·284	0·32	54·6
10	1	11½	38	8	19·3	9·81	0·088	0·181	0·18	106·6

According to Eytelwein, the length of the body pipe ought *not* to be *less* than $\frac{1}{4}$ of the height to which the water is to be raised. Its diameter in inches, (when Q'' is the number of gallons *expended* per *second*) $= 4\frac{1}{2}\sqrt{Q''}$. The diameter of the rising or delivery pipe should be one-half of this. The air chamber should be as large as the cube content of the rising pipe. The two valves should be close to each other, but it is of little moment whether the escape valve is above or below the air chamber, with regard to the stream of water. The opening of the escape or tail valve should not be less than the section of the body of the ram.

Example.

Let it be required to raise 220 gallons of water per hour to a height of 46 feet; the disposable head of water being 4 feet;—to determine the expenditure of water per second, and the principal dimensions of the ram—

220 gallons per hour = 2200 lb. = 36·6 lb. per minute;

$$36{\cdot}6 \times 46 = 1{\cdot}2\,P\,(4 - {\cdot}2\sqrt{46 \times 4}).$$

$$\text{or, } P = \frac{36{\cdot}6 \times 46}{1{\cdot}2\,(4 - {\cdot}2\sqrt{184})} = \frac{1403}{1{\cdot}29} = 1087{\cdot}6 \text{ lb. per minute;}$$

and 108·76 gallons per minute = 1·81 gallons per second.

Diameter of body pipe $= 4\frac{1}{2}\sqrt{1{\cdot}81} = 4\frac{1}{2} \times 1{\cdot}346 = 6$ inches, nearly.

Length of ditto should not be less than 44 feet,—say 50 feet.

Diameter of rising pipe $= \frac{6}{2} = 3$ inches.

Content of ditto $= \frac{3^2 \times {\cdot}7854 \times 46}{144} = 2\frac{1}{4}$ cube feet = capacity of air chamber.

Diameter of opening for escape valve = 6 inches.

If ball valves are used, their weight should be twice that of the corresponding bulk of water.

D'Aubuisson, p. 504, makes the following important remarks:—"The hydraulic ram has only been employed, hitherto, in raising small quantities of water, and, therefore, in producing small effects. The greatest effect obtained by Eytelwein from 1123 experiments was only 1476 lb., raised one foot in a minute; and the greatest from the rams used in France is but 7500 to 8500 lb., raised one foot in a minute, or about one half the work done by a horse, harnessed in a gin."

It is very doubtful whether the ram can be used for raising large volumes of water. The violent shock of the valves, and the heavy pulsations of the machine, derange the frame and the foundations made to support it. This it has been attempted to obviate by materially increasing the weight of the ram, and in this way the loss of effect arising from the movement of the machine may be diminished, and the evil remedied up to a certain point.

The strong frame-work and heavy masonry, constructed to support large rams, have been entirely destroyed after a certain length of time; and it is much to be feared, that the employment of this engine, in other respects so remarkable, will continue to be restricted, and that its sphere of usefulness will not extend beyond the supply of water to an isolated house or manufactory.

1, Lancaster-place, Nov. 5, 1846. J. H.

STABILITY AND STRENGTH OF HUNGERFORD BRIDGE.

In our last number (p. 358) we published extracts* from some remarks addressed by Sir Howard Douglas to the editor of this Journal, respecting the stability and strength of Hungerford Bridge, and promised to reply to the objections raised respecting the sufficiency of that structure. The objections are chiefly these—that the main chains are not strong enough—that the piers are not sufficiently stable, being liable to horizontal strains at their summits, which the shifting saddles do not entirely remove. The first point which we will consider is

The Instability of the Piers.

It is asserted that, owing to the difference of the form, &c. of the catenaries on either side of each pier, its head is subject to a force, tending to overturn it, which is represented by $a - a'$, where a and a' are the horizontal tensions of each catenary respectively.

Now this horizontal force $a - a'$ acts upon the shifting saddle. Let us consider the object of this contrivance. If it recede (that is, move towards the bank of the river), it increases the span of the centre chain and dimi-

* In order to make the extracts more complete, the following words ought to have been inserted, after the word "destroyed," which concludes the sentence referring to the diagram, "And these unequal strains which exist even when the bridge is at rest, are greatly increased by the vibrations to which it is subject, and particularly by the action of storms of wind. Unless the error be extreme, these unequal strains may not be productive of immediate disaster, but they are constantly acting, and by so much they aggravate the defects which have been pointed out as attaching more or less to all suspension bridges. Applying the above diagram to an accurate elevation of the bridge, and producing A D till it meet the horizontal line at the base of the pier, we may see to what extent the stability is endangered, and it is evident that beyond a certain point, the strain at the head of the pier would cease to be supported in the direction of the resultant A D. Seeing that this error has in point of fact been committed on several occasions, in constructing suspension bridges—that insecurity and failure have ensued—that in one instance which proved fatal, the error was of such magnitude as to make the angle on one side of a pier 71° 28', and on the other 56° 50', and that a very considerable error of this description exists in Hungerford Bridge," &c.

nishes its deflection:—*both* these alterations tend to increase the horizontal tension of the middle chain. At the same time it tends to diminish the span of the side chain and increase its deflection:—*both* these alterations tend to diminish the horizontal tension of the side chain. So that on the whole, if the horizontal tension of the side chain exceed that of the middle chain and the shifting saddle recede, there are *four* causes in operation to establish equality of tension. Conversely, if the horizontal tension of the middle chain exceed that of the side chain, and the saddle *advance*, there are four causes in operation to establish equality of tension.

But there are two ways by which the establishment of this equality may be prevented. Either the friction of the saddles on the piers may restrain them from moving, or a sufficiently large range of motion may not have been provided for in the construction of the bridge.

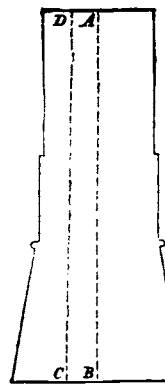
Let us consider first the effect of friction. By reference to the last volume of this Journal, p. 165, it will be seen that between the saddle and the top of the pier a number of rollers are interposed in such a manner that the friction is wholly of the nature of *rolling* friction: there is no *rubbing* friction, such as that at the axle of a wheel, or the pin of a pulley. It is known by experiment that rolling friction is exceedingly small, almost inconsiderable, compared with rubbing friction.

From experiments by Babbage, it would appear that weights placed on wooden rollers, 3 inches in diameter, can be moved with $\frac{1}{10}$th of the force required to move them when placed on wooden sledges. The friction of metallic rollers is a subject which, notwithstanding its importance, seems to have been greatly neglected. Of all the laborious and careful experiments upon friction which have been instituted by numerous investigators, comparatively few relate to rolling friction.

The rolling friction of any material depends not so much on its smoothness as upon its hardness: for it principally arises from the slight flattening of the roller where it is in contact with the plane, and the slight depression of the plane itself. Now in the shifting saddles of Hungerford Bridge these causes must operate very slightly, for each saddle rests upon 60 rollers placed almost close together and arranged in an ingenious manner so as to work with the utmost regularity. As we said, however, little more than a rough estimate of the friction can be arrived at; but we think that an inspection of the saddle itself will instantly satisfy any one that the coefficient of friction cannot be nearly so great as in a railway carriage. Now the friction of a railway carriage is about $\frac{1}{400}$th of its weight. This friction consists of two parts: the rolling friction at the circumferences of the wheels, and the friction of the axles. These axles are about half the diameter of the rollers at Hungerford, and the rubbing friction of the former must greatly exceed the rolling friction of the latter. Moreover, in the railway carriages the axle friction is only a part of the resistance, and therefore would be represented by a smaller coefficient than $\frac{1}{400}$; the roller friction of Hungerford Bridge would be represented by a still smaller coefficient. If then we make the friction on each saddle half the friction of railway wheels, or $\frac{1}{800}$ of the weight, we probably shall have considerably over-estimated it. Now the total weight on each pier will be scarcely 800* tons, supposing the passengers packed together as closely as they can stand, (a most improbable supposition.) In this case the utmost resistance to the motion of the saddle will be less than a ton. Consequently, if the "power represented by $a - a'$" exceed 1 ton, the saddle will begin to adjust itself.

It is impossible to suppose that masses of brickwork such as those which form the piers of Hungerford Bridge can be overthrown by a force of one ton. We believe, however, that we have greatly over-estimated the amount of this force. In addition we must remember that the vertical pressure on the pier has an effect as well as the horizontal, and that the former tends to the stability of the pier. In the extracts given, ante p. 358, there is a diagram in which the line A D represents the magnitude and direction of the resultant of the forces acting on the head of the pier. Let us suppose the diagram slightly altered, by constructing a parallelogram in which the *vertical* and *horizontal* pressures, instead of the tensions of the chains, are represented. Then A D represents the resultant of those pressures, and it is the diagonal of a parallelogram, of which the sides are in the proportion 1 (ton) : 800 (tons). We see then how extremely oblique is the direction of A D. If when produced it fell with the base of the pier, the pier would be stable, even if it had no weight, and the mortar no cohesion.

To illustrate this important point a little more fully, let us actually construct the diagram. Let A B C D be the parallelogram of the forces



applied by the saddle to the top of the pier, and let A B be the resultant of the *vertical* pressures exerted by the rollers: this resultant will always be somewhere near the centre of the tower. Let A D represent the horizontal friction of the rollers: then the diagonal joining A and C will represent the direction and magnitude of the resultant. Now, B C is only $\frac{1}{800}$th part of A B, and therefore, since the pier is 80 feet in height, the diagonal A C will, at the base of the pier, be only the $\frac{1}{10}$th of a foot out of the vertical. The base of the pier is 40 feet wide. If, therefore, the position of A B be supposed to be exactly central, the friction or horizontal force must be *two hundred times* what we have supposed it to be, before the resultant can fall beyond the base. If we take into account the effect of the weight and cohesion of masonry itself, the horizontal force must be still further multiplied, before the stability of the pier can be endangered.

Limits of the Motion of the Shifting Saddle.

The next point to be considered is, whether the motion of the shifting saddle has a sufficient range. We think that it may be satisfactorily shown that the saddle has ample room to adjust itself to any variation of the horizontal tensions of the chains which is likely to occur. It is difficult, in a subject so complicated as the theory of catenaries, to work out general solution of the problem; a little attention, however, to the case before us, and an allowable simplification of it, will furnish all the information required.

Let us first see the effect of a slight diminution of the span of the central chain, everything else remaining unaltered. In the tract on "Metropolitan Bridges," p. 10, the following useful approximate relations are given:—

$$2x^2 = 3y(s - y) \ldots\ldots (1) \qquad a = \frac{3y^2 + x^2}{6x} \ldots\ldots (2)$$

where s is half the length of the chain, y the half-span, x the deflection, and a the length which measures the horizontal tension. In the case of the Hungerford Bridge (supposing the curve to be a common catenary), the values of these quantities are—

Half the central span, y	338·25 feet.
Deflection, x	50·
Half length of the chain, s . . .	343·
Length measuring horizontal tension, a .	1152·5

where the first two quantities are found by actual measurement, and the two latter are those calculated by Sir Howard Douglas from his formulæ.

Now let us suppose the half-span to become 337 feet—that is, to be diminished by 1½ foot; and the length of the chain being unaltered, let us see what will be the new value of a. By equation (1),

$$2x^2 = 3 \times 337 \times 6\text{; or, } x = 3 \times \sqrt{337}.$$

Therefore, by equation (2),

$$a = \frac{3 \times (337)^2 + 9 \times 337}{6 \times 3 \times \sqrt{337}} = \frac{1}{6}\sqrt{337} \times (337 + 3) = 1054 \text{ feet.}$$

It follows, therefore, that by the small diminution of the span here supposed, a very great alteration of the horizontal tension is produced—namely, from 1152 to 1054, or in a ratio of about 11 : 10. The length a indicates not the actual value of the tension, but its proportion to the weight of the chain. Hence, whatever proportion the horizontal tension bore to the weight of the chain in the first case, it would bear $\frac{10}{11}$ths of that proportion in the second case. Now, in the construction of the Bridge, provision has been made for giving the saddles on each pier a play or range of three feet. And we have made the case far too unfavourable for our own view of it; for we have neglected the consideration that, when the saddle moves, the horizontal tension of the side chains is increased at the same time that the horizontal tension of the central chain is diminished. So that the adjustment would take place much sooner than has been here supposed.

The adjustment neglected in the above calculation is by far the most important in point of magnitude. For a variation of span would not nearly so much alter the tension of the main chain as that of the sides chains, of which the curvature is very small. The latter are stretched almost in a straight line between their points of attachment, at the banks of the river and the top of the piers. So that it may be doubted whether an increase

* The total weight of the centre chain when loaded is 1000 tons. One-half of this weight presses each abutment, and 300 tons more may be added for the side chain.

of their span much beyond a foot, would be geometrically possible if the length of these chains be supposed constant. We know that if the chains were absolutely straight, their tension would be infinite, and as an approximation to the straight line must produce an enormous increase of tension, there need be no fear that the range of the saddles of Hungerford Bridge would be insufficient for the requisite adjustment.

Approximations similar to those used above would scarcely be suitable for calculation of the variations of the side chains, of which the tension alters so rapidly for slight alterations of span that the approximate expression must be continued to a much greater number of times to be at all satisfactory. This objection does not however obtain respecting the main chain, in which the variations of tension are not so rapid.

We have also followed Sir Howard Douglas in assuming the chain to be a common catenary, and the load to be distributed uniformly along the curve. These suppositions might be dangerous, if the strength of the chain were being discussed, but for the purpose of estimating roughly the effect of variations of the span, they seem sufficiently accurate. We may as wel remark that the calculation of the strength of the main chain, which is quoted in the last volume of this Journal, Vol. VIII, p.65, is exceedingly incorrect and unscientific.

In the tract on Metropolitan Bridges, and in the Reply to our remarks, several analytical difficulties have been suggested which certainly appear to militate against the conclusions here arrived at. These difficulties are not however insuperable, as the consideration of the following passage, which we quote from the original pamphlet will show.

"In the case of the Hungerford Bridge, however, the catenaries at the two ends when completed, have a considerably less span than the central curve, but they have the same droop or deflection. Hence if $2y$ be the span of the centre arc, $2y'$ the span of the curves at the two extremities when completed; and a, a', the corresponding tensions at the lowest points, we have

$$a = \frac{3y^2 + x^2}{6x} \qquad a' = \frac{3y'^2 + x^2}{6x}.$$

And as y' is considerably less than y, a' will evidently be less than a in a still higher ratio. Hence there will be a constant horizontal strain, equal to $(a - a')$ acting at the top of each pier."

The supposition that the side chains "have the same droop or deflection" as the central chain, is a misapprehension as to a point of fact—they have a considerably greater deflection. Hence in the second of these equations we must put for x, a larger quantity x'. This correction is a satisfactory solution of the difficulty suggested. The extracts quoted last month from the Reply, contain the following clause in the sentence explaining the diagram.

"If the tangents of the curves formed by the heads of the piers do not make equal angles with the vertical line A V, even if the tensions of A B, A C, were equal (which is not the case in Hungerford Bridge), the resultant of the strains at A would be in the direction of a line A D," &c.

It seems to have been overlooked that the fact alluded to in the parenthesis, and the fact suggested just previously, are of a compensating nature If there be an inequality, not only of the amount of the two tensions, but also of their angles of inclination, the resultant *may* be vertical—if only one of these inequalities exist, the resultant cannot be vertical.

To Sir Howard Douglas belongs the merit of having suggested for discussion a subject of great interest to engineers and the public generally; and of having considered the question in that purely argumentative manner which always ensures respect in a scientific controversy. He will, we are sure, give us credit for having the same object in view as himself—that of ascertaining the truth; and if our reasoning should appear erroneous, we shall be quite ready to be set right. Of the strength of the main chains of the bridge we have not as yet said anything, as we are not in possession of all the data. These however are promised to us, and a separate paper on this part of the subject shall, if possible, appear in our next number.

AMATEUR ENGINEERING.

The English Government is distinguished from those of other countries by its reluctance in assisting or rewarding the efforts of mechanical inventors. There is no doubt that from the operation of this rule many valuable discoveries are lost to the country, which has a direct interest in promoting those scientific labours which tend to the benefit of the whole community. At the same time, it is certain that an indiscriminate encouragement of inventors would subject the country to an overwhelming number of claims on the behalf of futile immature and valueless schemes.

The restrictive rule observed by our Government is however occasionally relaxed, and it happens, unfortunately, that the occasions chosen for this relaxation are those where the least benefit results to the country, and the consideration shown to favoured individuals is least deserved. We allude to public encouragement of amateur ship-building and marine engineering. It would be invidious to point out all the instances in which the public money has been recently squandered in constructing war steamers upon plans suggested by persons whose occupations and previous studies by no means qualified them for the task undertaken by them. Of course the inventors themselves stoutly deny the failure of their plans, and can overpower us with proofs of their success; but the professional engineer will immediately recall numerous instances in which persons possessed of Parliamentary influence, or the advantage of titles to the peerage, have been able to waste many thousands of pounds of public money in the manner alluded to. We may, however, take one instance where failure has been so obvious that denial would be impossible. The *Sidon*, the offspring of Sir Charles Napier, was intended to have been a lesson to all future engineers; and such indeed it has proved—in the way of salutary warning.

If it be determined that the rule of discouraging inventors is to have exceptions, they ought not surely to be so selected that the possible failures shall be productive of the *greatest* amount of loss. Judging *à priori*, we might suppose that naval construction on which the strength of Great Britain depends, and of which the operations are necessarily of the most costly kind, would be the very last branch of the industrial arts chosen to be subjected to the experiments of inexperienced amateurs. We might suppose that the building of steam and other vessels of war, involving as it does, in every case, a vast expense to the country, would be conducted with the utmost caution, and would be intrusted solely to careful and experienced hands. It would seem a matter of common prudence that if amateurs must be encouraged in their taste for practical mechanics, they ought to try their 'prentice hands on some work a little less costly than ship building.

But the Government is not alone responsible for the errors in question, which have been largely participated in by companies of private individuals. A clever busy man, with a good deal of intrigue and energy, may often get up a company, which he can coax into an encouragement of his own private schemes, or those of the *clique* to which he belongs. The *Great Northern*, built at Londonderry, by some one who, from modesty (or more probably. from prudence), has not trumpetted forth his name, was to have been a model of Irish steamers for English engineers; but alas, turned out but ill The restorative applications of London engineers—Miller, Ravenhill and Co., were found requisite *intus et in cute* before the unfortunate victim of mechanical dabblings could be brought to a state of vigorous healthy action.

The *Great Britain* again was a woeful example of amateur patchwork. The public were invited to inspect and admire this gigantic specimen of ship-building; and attracted by her magnitude and showy decorations, they inspected and admired accordingly. Could a promiscuous crowd of visitors be supposed likely to scrutinise the proportions of the engines, the size, shape, and arrangement of the small and inconspicuous parts, and all those *minutiæ* which, as the professional engineer knows, constitute the excellence or worthlessness of a marine engine? The history of this vessel has been a series of unfortunate mistakes from beginning to end. First, she was built in docks of which the opening was too narrow to permit her exit. The chrysalis grew and increased in stature, and when the time came for quitting its wingless state, and going forth freely into the world, was found unable to emerge from its integument. However, these difficulties, the result of gross bungling, were at last got over. But the troubles had only just commenced. The engines were found to be—what engines might have been predicted to prove, which were constructed by men who had never undergone the discipline of an engineer's workshop. Professional engineers were again called to the rescue, and this time, Mr. Field, of the firm of Maudslay and Field, was the re-operator.

At present, the Great Britain lies upon the coast of Ireland, beaten and buffetted by the wind and tide. No one knows how she got into her presnet position; this, like all her previous adventures, has the charm of mystery about it—a mystery which baffles human penetration. There is a convenient complexity about the story, which averts condemnation by puzzling the judgment. Bristol charts not drawn as they ought to be, the Isle of Man appearing where it ought not to be, the captain's notions of time and space, the advantages of an untried course to the north of Ireland, the directors complaisance, and barrels of gunpowder placed behind the vessel to blow her—not up—but off:—these are the materials of the story; of which the only certain part is the event—namely, that the Great Britain lies ashore in

Dundrum Bay, beaten and buffetted by wind and tide, as aforesaid, and that she is reserved for further amateur experiments.

As no lives have as yet been lost in these experiments, one would not grumble at their having been carried on with a view to the advancement of practical science, if they had been conducted with some regard to economy. But what is chiefly to be complained of is, that experience has been purchased at so dear a rate. Fifty thousands to a hundred and twenty thousands of pounds are not trifling sums to pay in experimenting. Are we to suppose that engineers like Watt, Maudslay, Miller, Seawards, Penn, or Napier, acquired in a day the experience necessary for the construction of marine engines of from 500 to 1000 horse power? A man must flatter his inventive talents most outrageously if he supposes that they can compete against the *accumulated* knowledge of others, who, even if for argument sake we suppose them greatly inferior in individual capacity, have yet been working together for years in the same pursuits. It is impossible to imagine that the abilities of one man can ever so greatly surpass those of the rest of mankind as to enable him to contend against the long-continued and *co-operating* efforts of his fellow labourers. We do not wish to give to experience more than its due share of merit; but it is obvious to every one who knows any thing of marine engines, that the most profound scientific knowledge, and the most brilliant inventive talents, will not alone constitute a practical engineer. Long, laborious, even painful, experience must be superadded.

That every man is to be trusted in his own art—*cuique in suâ arte credendum est* is a proverbial expression, and like other proverbial expressions involves both truth and falsehood. The man who is constantly in practice of the technical rules of his profession, and who trusts to his experience alone, will frequently become the slave of routine. He has got into fixed habits of thought—like the mill-horse he can only go his round: and a valuable idea which would occur to a mere bystander may be overlooked by him. The extra-professional suggestions of clever amateurs or men of science are not discouraged: and the professional superciliousness with which such suggestions are frequently met is destestable. But there is a great difference between encouraging the suggestions of inexperienced persons, and suffering such persons to carry out their ideas independently of professional control; especially when the works undertaken are of such magnitude as the *Sidon*, the *Great Northern*, or the *Great Britain*.

THE NEW PLANET.

The dispute respecting the discovery of the new planet is likely to be brought to a satisfactory termination. At a meeting of the Astronomical Society, held during the last month, the Astronomer-Royal read a paper, tracing the investigations from the commencement, and distinctly assigning to Mr. Adams his priority of right and title to the discovery. Professor Airy has been in correspondence with both M. Le Verrier and Mr. Adams, and his paper was supported throughout by original letters and other authentic documents, of which the dates are indisputable. He allows fully to M. Le Verrier the merit of having performed his investigations independently, and of having, in the first instance, announced his results in a more public manner than Mr. Adams. The latter contented himself with depositing in the Greenwich and Cambridge observatories the calculations necessary to facilitate the search for the planet with the telescope.

It is very important to remark, that the calculations of Mr. Adams were not only the earliest, but by far the most ample and recondite. M. Le Verrier contented himself with publishing last June the heliocentric longitude of the planet. *In addition to this*, Mr. Adams announced its *mass*, *longitude of perihelion*, *and eccentricity* — infinitely more difficult and complicated investigations than those to which M. Le Verrier restricted himself. No one would wish to detract from the merit of the latter, but to compare his labours with those of his scientific opponent would be ridiculous.

It is very gratifying to learn that the paper read by the Astronomer-Royal, and Mr. Adams's investigations, are about to be published. The world will then have the opportunity of examining the two independent investigations. Men of science will confine themselves to the examination of them on their own merits, irrespectively of all considerations of the time when they were made, and we doubt not that even the French philosophers will allow the superiority, in this respect, of the claims of the Englishman. The publication of the paper read by the Astronomer-Royal will also confirm, on the highest authority, the assertion made in these pages last month, that Mr. Adams's claims were prior in point of time, as well as intrinsic merit.

The opponents of this view of the question are now shifting their mode of attack—a sure sign that they are losing ground. They say that the announcement to the French Academy was *more public* than that to the English astronomers, and that according to a conventional rule in these matters, the discovery belongs to him who makes his announcement in the most public manner. But what more could be required of Mr. Adams than that he should deposit his results in the principal public observatories of Great Britain? He made known his discoveries to the Astronomer-Royal, and through him to the whole body of English astronomers—Sir John Herschell, for instance, was perfectly aware of Mr. Adams's investigation, though the information reached him in no other way than through the Greenwich observatory. Besides, the papers were deposited in the very places where alone the requisite telescopic observations could be undertaken. Had Mr. Adams the least suspicion that any attempt would be made to wrest his rights from him, he might, with the greatest ease, have precluded the attempt effectually. The French Academy may hug their self-conceit, and extol M. Le Verrier for having flattered it by addressing his communication to them; but let them not accuse Mr. Adams because he has not imitated this course, but acted more soberly and quietly. The publication made by him was quite sufficient for all *useful* purposes—not quite sufficient, it seems, for show and ostentation.

Many great mathematical discoveries have heretofore been communicated in a far more private way, and yet the claims of the discoverer remain incontestible. John Bernoulli first announced the general principle of Virtual Velocities in a private letter to Varignon. Is therefore the merit of his discovery the less because he stated it through the medium of ordinary correspondence? The different modes of making a discovery known are comparatively trifling; and certainly if in the case before us a comparison must be made, it results in favour of Mr. Adams, who chose the method most advantageous—not to his own fame—but to the interests of science.

There is one consideration however which may perfectly satisfy us in all these disputes. Whatever discussion may now exist as to the proper *conventional* method of making known a discovery, posterity will concern itself little in a debate so trifling and artifical. Future generations of philosophers will be more anxious to know the author of the discovery, than the *etiquette* which ought to be observed on the occasion. These foolish ephemeral quibbles will be forgotten with the authors of them; and the great sterling fact will alone remain, that our countryman was the first man in the history of the world who looked into the firmament with prophetic sight, and discerned there a new world—weighed it, measured it, and traced the course of it, while as yet unseen by human eye.

One of the magazines speaks of Mr. Adams as an under-graduate! It is provoking that these "scientific journals" do not confine themselves to subjects of which they know a *little*. Mr. Adams took his degree as senior wrangler, is fellow and lecturer of St. John's, and the University moderator for next year.

The following may be relied upon as an accurate sketch of the history of Mr. Adams's labours. We should not perhaps be justified in stating the authority for this statement, but the reader may be assured of the accuracy of the dates. The resolution of endeavouring to account for the perturbations of the motion of Uranus by the action of another planet, was first formed by Mr. Adams in the year 1841; and it appears, from memoranda, that finding, in the summer of that year, the labour of calculation to be so great, that, if undertaken at that time, it would seriously interfere with his academical studies, he resolved to defer, until after taking his degree, the investigation which was to determine approximatively the place of the disturbing planet, and thus assist astronomers in discovering it by actual observation. In the course of 1843 *(three years ago)*, the first approximation to the place of the planet was arrived at by Mr. Adams, and the calculations, though comparatively rough, were sufficiently close to satisfy him that his hypothetical explanation of the anomalies in the motion of Uranus was a correct one. In February, 1844, having obtained from the AstronomerRoyal the observations made at Greenwich since 1781, he renewed the investigation of the problem, and this time rendered it much more complete than before. Several solutions were obtained, differing but very slightly from each other; and by successively taking into account more and more terms of the series expressing the perturbations, first in April, 1845, again in May, and finally in September of that year, the ac curate solution of this wonderful problem was at last obtained, and was immediately communicated to Professor Challis, and in the following month to the Astronomer-Royal. Both Professors were therefore in possession of the perfectly complete solution upwards of a year ago.

MOVEABLE JIB CRANES.

Remarks on the utility and defects of the Moveable Jib Crane, according to the construction now generally used in Glasgow, with proposed Improvements to obviate its defects. By William Gale, Glasgow. ***Read at the Institute of Civil Engineers. (With Engravings, Plate XIX.)***

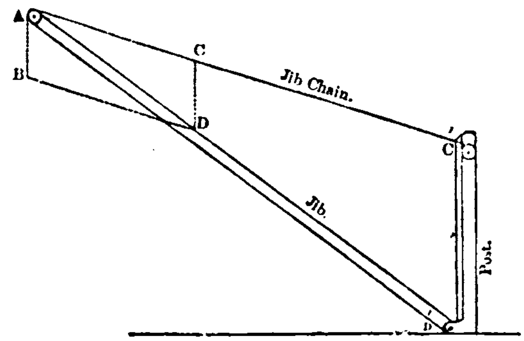
The author's attention having been recently drawn to an examination of the causes of numerous accidents (many of them attended with fatal consequences) during the erection of some of the public buildings in Glasgow and the neighbourhood, he found that one of the most fruitful sources of these accidents was the defective construction and injudicious use of the moveable jib crane. This crane, it may be remarked, has nearly superseded all others used by builders in Glasgow, and is at present employed at most of the public buildings in course of erection. It has, however, undergone material alterations since its introduction by Francis Watt upon Mr. Stevenson's works, during the erection of the Bell Rock Lighthouse; but while undergoing these modifications and changes to suit convenience, the principle of construction has undergone a change, which has increased the strains to a very considerable extent.

As originally constructed, the post or upright *a* was from 20 feet to 30 feet long, the jib *b* being of about the same length; the upright was supported by gye-ropes or chains, similar to the mode usually adopted in quarries; but at present the post is reduced to 15 feet in height, and the jib is extended to 50 feet in length, whilst the inconvenience or rather impracticability of getting the gyes fastened in many cases, such as in erecting street buildings or quay walls, where there is a great traffic, led to the substitution of the two arms *c*, *d*, and the framing (Plate XIX. fig. 1); and, in order to prevent it upsetting, the framing is loaded with stones, or other heavy materials, or when placed on the upper stories or roof of a building, which is frequently done, the framing is lashed down with chains to some fixed points beneath. It will at once appear evident that this alteration in the construction, by shortening the post or upright *a*, and lengthening the jib or derrick *b*, must have increased the strain on the jib chain to an enormous extent, and in many instances the accidents occurred from the snapping of the chain.

No one who has seen this crane in operation can call in question its great utility to the builder, on account of the expedition and ease with which heavy blocks can be bedded over a considerable extent of front, without moving the position of the crane after it has been once fixed down; but the point to be objected to, is the great amount of strain thrown on the jib chain, even with moderate weights attached, when the jib is worked at a great inclination from the perpendicular, and when it is considered that a weight of 4 or 5 tons is frequently suspended from it, it is certain that if builders were only made sensible of the risk, they would be more scrupulous in hazarding the lives of those under their charge, and fewer accidents would be heard of.

From what has been stated it will be obvious, that the total strain thrown on the jib chain depends upon various causes. 1st, The length of the jib. 2nd, The height of the post. 3rd, The inclination of the jib. 4th, The weight attached. 5th, The proportion of weight due for the jib itself, with its mountings and chains; and 6th, The friction. Aware of the danger of trusting to theory alone, in making an accurate investigation into these sources of strain, the author had recourse to a variety of experiments, by model, being at the same time sensible of the fallacious nature of the results deduced therefrom, unless increased size and weight, and consequently increased leverage and friction, were all accurately calculated and allowed for. After numerous experiments, however, it was found, that a near approximate agreement took place betwixt the results brought out by the model and those deduced from theoretical investigation for the full-sized machine.

In the theoretical investigation of the question, the weight to be raised being known (which must include the proportion of weight due for the jib, &c., along with that due for friction), it is only necessary to apply the parallelogram of forces in the usual way, in order to obtain data whereby to ascertain the strains; thus if A B represent the total weight, B D = A C gives the strain on the jib chain, while A D represents the strain on the jib. Or if C′ D′ represent the total weight, A C′ and A D′ respectively represent the strain on the jib chain, and the jib or derrick.



Keeping in view, that the great utility of this crane, for street erections, consists in its having a long jib and short post, it became an object to improve the acknowledged defective part of the machine, the jib chain, not by adding strength to the chain itself, which had already been done by builders, until it was rendered quite inapplicable for winding round a barrel of 8 or 9 inches in diameter, but simply by introducing a pulley between two rods of iron, bolted to the point of the jib *b*, as shown in Plate XIX., figs. 1 and 2, and having the end of the chain attached to the top of the post or upright *a*, instead of attaching it to the point of the jib. A mechanical advantage was thus gained, and a much lighter chain than had hitherto been used, could with safety be adopted. The loss of speed was more than compensated by the increased ease with which the jib could be worked; but speed in this part of the crane was of little importance, as the jib was generally placed at the required angle, or nearly so, before commencing to raise the block. This is the chief improvement, which it is intended to suggest where this description of crane may be found suitable. It is preferable also to increase the diameter of the pulleys from 10 or 11 inches to 18 or 20 inches. The importance of using large pulleys does not, however, seem to be sufficiently appreciated by the builders, otherwise they would not allow their machines to be fitted up with smaller ones. Lastly, the friction caused by the angle of the jib chain, after passing the pulley in the post to either side of the barrel of the wheel and axle, may be obviated to a considerable extent, by confining the chain to a barrel of from 20 to 24 inches in length, (fig. 3.)

The strength of chain necessary for working the jib of this crane will depend on the nature of the work, but for general purposes a chain made of the best iron, $\frac{5}{8}$ths inch or $\frac{11}{16}$ths inch diameter, will be found amply sufficient.

As some builders might prefer using a rope instead of a chain for working the jib, the back view of a crane (fig. 3), and the jib head (fig. 4), are shown. Two pulleys are introduced at the end of the iron rods, the other end being bolted to the end of the jib, as in fig. 1, and a third pulley is fixed to the top of the post. The rope is fastened to the barrel of the wheel and axle, thence it passes over a pulley fixed on one side of the post, and then over one of the pulleys at the end of the iron rods; it then returns to the pulley at the top of the post, and passing over the other pulley at the rods, returns to that fixed on the other side of the post, and is fastened to the barrel of the wheel and axle. Thus there is one continuous rope, equally strained by means of the pulley at the top of the post. By having also the barrel of the wheel and axle divided into two compartments, as shown in fig. 3 (back view), the one compartment being about two inches larger in diameter than the other, the whole of the pulleys will be set in motion when the jib is working. The rope necessary to work this crane may vary from $1\frac{1}{8}$ to $1\frac{3}{4}$ inch in diameter, according to the weight of the materials used, and it would be preferable to a chain, where this construction is adopted. Fig. 5 is another view of a jib head, showing the attachment of the rope and pulley to the jib head. The scale of Fig. 1 is drawn to a scale of 10 ft. to $\frac{3}{8}$ of an inch, and the remainder of the figures double the size.

WARPING HAULAGE ON CANALS.

A new system of haulage has been tried for the first time in this country on the Regent's-canal, through the tunnel under St. John's wood, Paddington. It is the invention of Captain Beadon, and is said to have completely succeeded. We have some impression that a similar system has been adopted in America for passing up the rapids. That does not detract from its merits, but otherwise, proves that the invention is a practicable one. The plan consists of a steam tug-boat and ropes, as shown in the annexed engravings. Fig. 1 is a side view, and fig. 2 a plan view, of a vessel fitted with steam power and the haulage ropes.

A A engine and boiler, B C two reels or cylinders, carrying wire ropes D and E, passing out fore and aft of the said boat. These reels have in front of them guides to regulate the wire ropes in winding up, and passing off such reels, and they are connected with the driving shaft of the engine by endless chains, shewn in fig. 2, and are placed in the boat fore and aft the engine and boiler. Each reel contains six miles of wire rope, which is alternately laid down in the bottom of the canal. The ends of these ropes are attached to the reels, and the two other ends of such ropes are fastened to posts in the canal banks; and when the one, say the rope D, is wound up, the entire working end of the other, E, is down in the canal. The reels are thrown in and out of gear by the reversing motion of the engine.

Fig. 1.

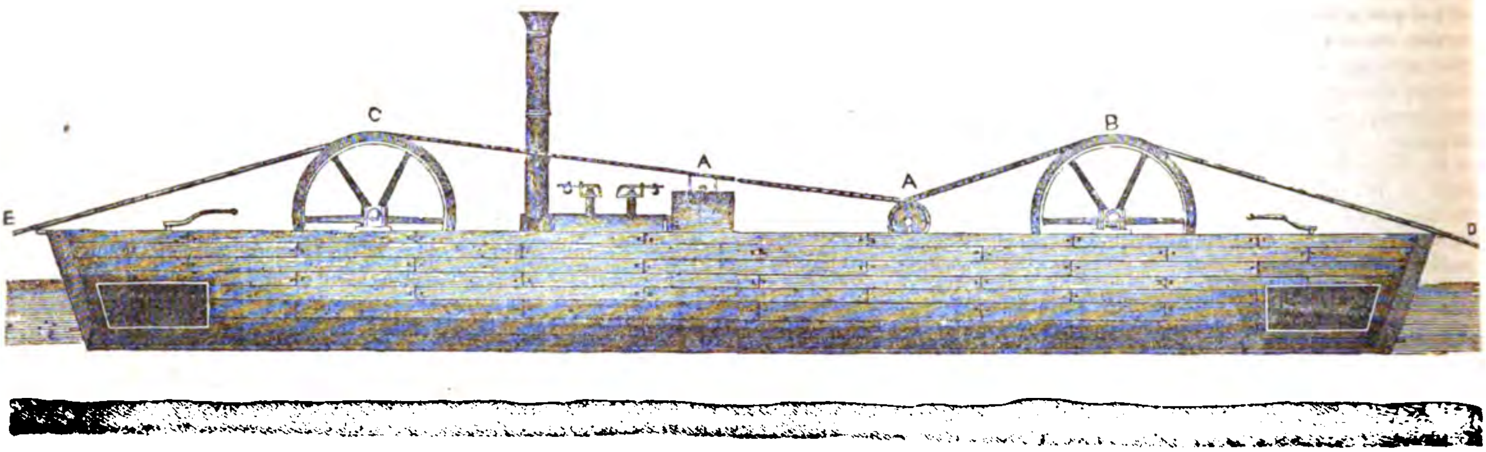


Fig. 2.

The action of the boat is as follows: the reel C is thrown out of gear, and the reel B into gear, the engines are set in motion, and the cylinder or reel B revolves and winds in the rope D, whilst the cylinder or reel C being out of gear with the engine, is free also to revolve, and does so by the traction of the rope E, which is thus gradually delivered down into the canal as the boat proceeds along. As soon as the boat arrives at the end of the rope D, the engine is reversed, the cylinder or reel B is thrown out of gear; this then begins to wind the rope A, and the cylinder B to deliver the rope D; so that, in fact, by simply winding in and out of the two ropes is the boat propelled along backwards or forwards six miles each time.

To tow barges or boats along, they are attached by a tow-rope to this boat, and proceed with it to the end of its rope or station. They are then disconnected from the boat, and attached to another similar one, and taken other six miles, and so on to the end of their journey. The canal is thus divided into a series of stations, having tug-boats to start at appointed times, so that boats, as they arrive, are forwarded with regularity.

RAILWAY CURVES.

Sir,—At the time I handed you the sketch and description of my instrument for simplifying the tracing of railway curves on the ground, and published in your Journal for November, p. 332, you called my attention to a method suggested by your correspondent, "*An Engineer out of Employment*," in the Journal for October, p. 300.

Where the extremities of a chord line have been already ascertained and given, and seen, there can be no doubt of the simplicity and accuracy of your correspondent's method, provided the localities be suitable for its execution. Indeed, I am much inclined to think that, under those circumstances, it is superior, being less complex, to any other method I have met with.

I would suggest that it is better to avoid referring to tabular information; but to be as independent of it as possible. The *versed sine* of any arc may be readily found, where the radius and chord are given, by the 47th problem of the First Book of Euclid:—From the square of the radius deduct the square of half the chord of the arc, and the square root of the difference deducted from the radius, will give the versed sine, or offset, for any segment. After this, the time and trouble of chaining the whole length of the chord of half the arc may be saved, for it will be found to be equal to

$$\sqrt{\tfrac{1}{4}\,(\text{the chord of the arc})^2 + (\text{versed sine})^2},$$

so that only the half of it will be required to be measured; and, at this point, its versed sine may be found as in the whole arc; that is—From the square of the radius of the whole arc, deduct the square of half the chord of half the whole arc; and the square root of the difference, deducted from the radius of the whole arc, will be equal to the versed sine of half the arc; and so on, *ad infinitum*.

The chief object I had in view, in recommending the use of my instrument, was its applicability, almost, I may say, under any circumstances. When obstacles occur, for instance, the tangent may either be made to work past them, or to stop short of them, &c.; a new calculation will of course be requisite to be made at each alteration of the tangent, but that can very soon be done. Another advantage is, that it does not require to see further than the length you choose, or find it convenient to make the tangent.

Wm. Tait.

Military Library, 30, *Charing Cross.*

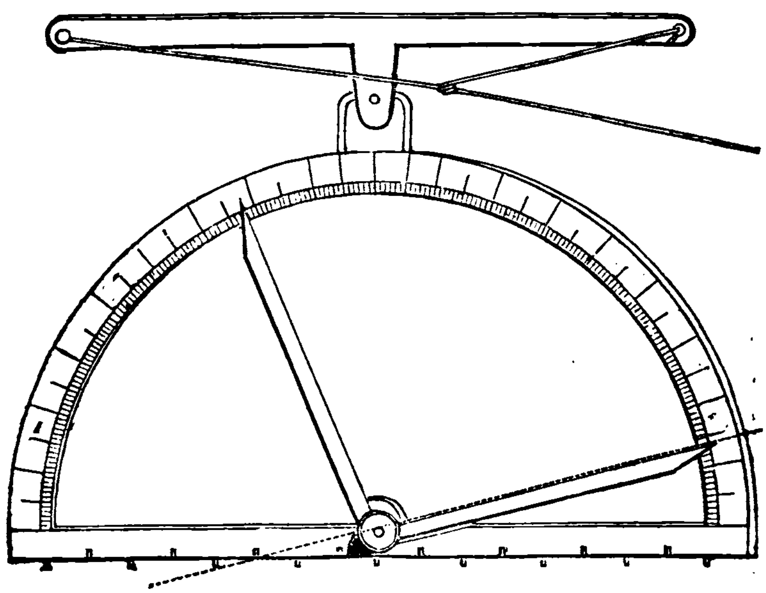
N.B.—In the description of my "Curve Tracing Instrument," "*a b*" is used for *c b*, and "effect" for *offset*.

EARL'S GONIOMETRICON.

(Registered by Mr. George Earl, *School of Design, Peckham.**)

The great recommendation which this instrument has received from the *Pictorial Times* induces us to lay it before our readers. We doubt not it will be found to be a very serviceable appendage to the travelling architect. The following is a description of the instrument as given in the above journal.

Fig. 1.



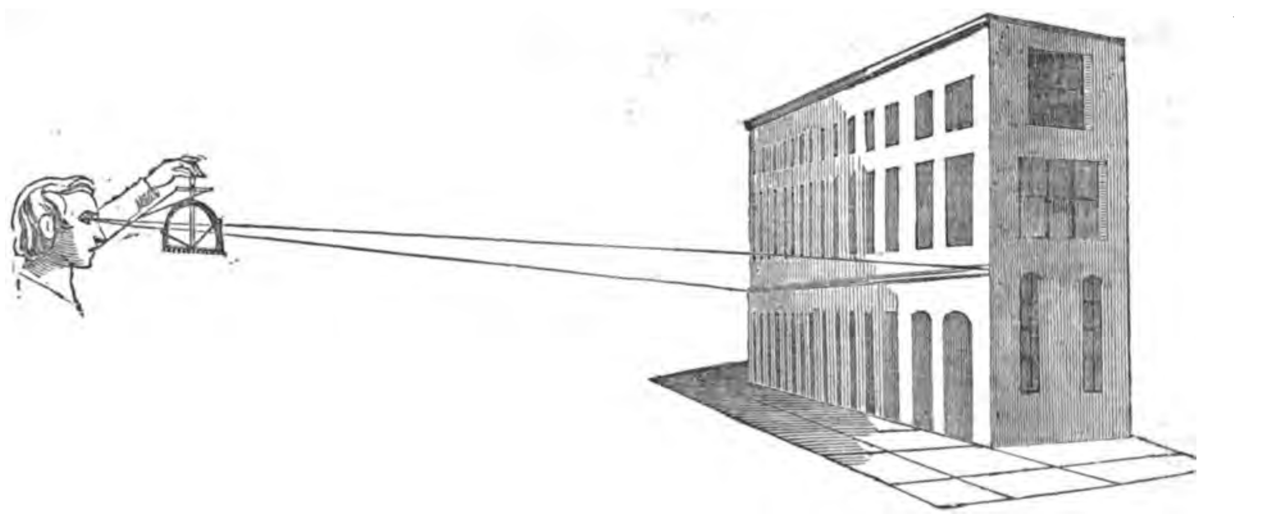
"This neat, elegant, and portable delineator has been contrived to enable persons unskilled in drawing to find the perspective direction of the vanishing or receding lines of objects. This it does with an ease and accuracy which is almost fascinating. All practitioners, and persons in the habit of sketching architectural or other complicated views, know the extreme difficulty of getting the leading lines of the picture projected with accuracy, and how easily the subordinate parts fall into their places when once these are obtained. This difficulty the goniometricon obviates, and with its assistance the most uninitiated may hereafter master the art of drawing in correct proportionate perspective. The mode of using the instrument is thus described by Mr. Earl:—Place the instrument between the eye and the object to be outlined, which is done by holding it with the finger and thumb of the left hand, at a point between the top of the arc and the universal joint. It is then fixed in that position at an angle of 60 degrees with the line of vision, a task accomplished by taking a small ivory acorn attached to the instrument by a string, and placing it firmly between the teeth, when the connecting string is stretched to its fullest tension. This done, the instrument is moved till one of the indicators (which in the cut looks like the hand of a clock,) coincides with the line whose downward or upward direction it is sought to ascertain. That point discovered, the instrument is laid flat on the drawing-paper with the horizontal bar parallel with its lower line, and gently moved to the required position, when the line of direction is ruled off from the edge of the indicator. The bottom of the instrument is set with divisional points, to assist in sketching the proportions of figures, trees, and objects of irregular form or outline.

"We have only to add to our recommendation of the goniometricon, that it is much used by artists and travellers, and recommended to general use by no less a person than the Astronomer Royal."

The Engraving, fig. 1, is a front view of this very ingenious and useful instrument; fig. 2 exemplifies the manner of its application.

Besides the valuable testimonial referred to, from Professor Airey, we observe there is one from Mr. Reynolds, of the Kew Observatory, who says—"Your instrument is precisely what Dr. Priestley, in his valuable work on perspective, hoped some mechanical man would discover, in order to make the science of perspective tangible to the comprehension of all."

Fig. 2.



* We are indebted for the use of the wood engravings to our cotemporary, the "Mechanics' Magazine."

BLASTING UNDER WATER.

Paper on the application of Gunpowder as an instrument of engineering operations, exemplified by its use in blasting marl rocks in the River Severn. By George Edwards. *Read at the Institute of Civil Engineers.*

Many plans have been proposed at different times for the improvement of the Severn. It is sufficient, however, for the present purpose to state, that in 1842 an Act was obtained under the advice of Mr. W. Cubitt, V.P. Inst. C.E., for the improvement of 43 miles of its length, from Stourport to Gloucester; over which distance, in many places there was not 2 feet depth of water during the summer season. The object of the proposed works i to increase this depth to 6 feet of navigable water during all seasons. Above Worcester the additional depth is obtained partly by dredging, but chiefly by a series of four weirs, varying between 300 and 400 feet in length, with side locks for the the traffic. Between Worcester and Gloucester (a distance of 29 miles), it is proposed to obtain the required depth, partly by contracting the channel by embankments of fascines, and partly by dredging. Messrs. Grissell and Peto having undertaken the entire completion of the works, from Stourport to Gloucester, the superintendence of the dredging operations was entrusted to the author. The shoals to be removed by dredging are generally isolated, varying from 100 yards to half a mile in length, and they require excavating to a depth of from 3 to 5 feet. A large proportion of these shoals consist of alluvial gravel, without flints, but principally of quartzose and granitic pebbles, varieties of porphyry and of compact and granular sandstone. This material, although very hard in some places, offered no engineering difficulties. Other shoals consist of denuded beds of hard red marl; this material being found in every instance, when the river impinges upon the eastern or western limits of its valley. In most places it was so hard, as to render its removal by the dredging machine quite impracticable; and it is the object of the present communication to describe the method of blasting, or breaking up this material, with gunpowder, so as to render it capable of being dredged up with facility.

That part of the river Severn, above described, traverses nearly north and south the great plain of red marl of the new red sandstone formation, the bed of the river from Stourport to about a mile below Holt bridge, near Ombersley, being formed through the upper strata of the new red sandstone; upon this lies the great bed of red marl (in places saliferous), dipping at a small angle, but irregularly, to the south east. The river traverses the whole of this strata, which is probably more than 1000 feet in thickness, passing through the upper strata, and entering the lias formation above Gloucester.

The red marl is generally considered by geologists to be formed from the debris of older rocks, and it appears to be totally devoid of organic remains. It lies generally in beds, rarely exceeding 15 inches in depth, and often much less. It is divided occasionally by strata of greenish grey marl, and near the upper part of the formation by thin, but very hard, beds of shaly, or imperfect lias.

It is difficult to describe the comparative hardness of materials, but when it is stated, that in many places it was impossible to cause a steel chisel-pointed boring tool to enter it by any ordinary exertion, by hand, from a boat, it will be conceived that it could not be readily raised by dredging. After exposure to the action of the air it breaks up into small fragments, almost like the slaking of lime, so that solid blocks, which could only be broken by the application of considerable force into sharp-edged fragments, would, in the course of a few days, fall to pieces and afford no criterion of its hardness in an undisturbed state.

When the dredging machine was tried upon one of these marl shoals, it was found impossible to raise above 50 or 60 tons per day, and that with constant risk and repeated accidents to the machine; but such rate of progress was totally incompatible with the required progress of the work. Attempts were first made to break it up by driving iron bars into it, and prizing it up, but this plan did not answer. A second attempt was made to loosen it with a very strong plough, something like a "subsoil" plough, which was proposed to be pulled through the marl by a powerful crab fixed on a barge, the plough being guided by a strong pole; the effect produced was, however, so superficial, and the expense of labour was so great, that this method was also abandoned, and experiments were made to ascertain the effect and probable cost of using gunpowder. These were so satisfactory, that it was determined to blast all the marl shoals, previous to dredging them. In January, 1845, as soon as the requisite materials and establishment could be prepared, this operation was commenced, and has since been carried on with no other interruptions than those occasioned by freshes in the river; the total length of blasting required (about a mile and a half,) being now nearly completed, and a considerable portion of the marl since dredged up, at the rate of 200 or 300 tons per day with perfect facility.

The most economical method of using powder, to break up a depth of rock like that described, would probably be to obtain a face of the required depth at one end of the work, to put in a row of shots at the back of it, and after each discharge to remove the loosened marl; continually repeating the process; but this method would have been open to many serious objections. The dredging machine and the blasting gang would have been constantly waiting for each other, and having but two dredging machines to perform the work, it was of great importance to economise their time in every possible way. By such proceedings also, a constant obstruction to the navigation would have been created, equal to the whole width of the new channel. The number of men that could have been employed in blasting would also have been very limited. These objections, in this particular instance, far outbalanced any little saving of gunpowder. It was therefore determined to put in perpendicular shots, throughout the site of the channel, at such distances as experience might prove to be best, and proceedings were commenced with spaces of 6 feet from centre to centre of the shot holes.

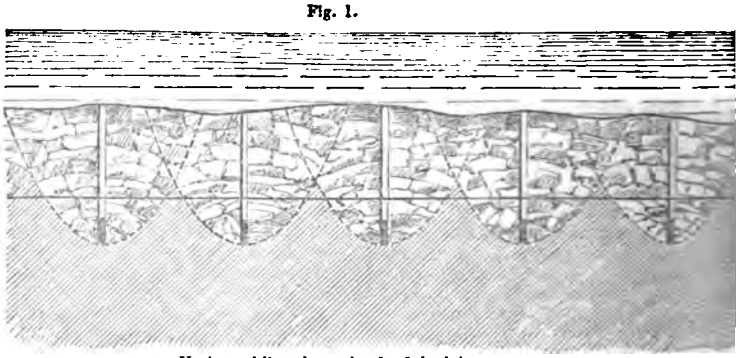
Six rafts were used, as stages to work from: they were each formed of four baulks of timber, about 40 feet long; the baulks, placed in pairs, were secured at a distance of 4 feet apart, by cross pieces, 6 inches square, well spiked to the baulks at intervals of 6 feet; these were covered with deals 3 inches thick, laid lengthways of the raft, a space of 12 inches in width being left open along the centre. The ends of the rafts were provided with strong ring bolts to moor by. These rafts were confined to one bank of the river by ropes, and retained at the required distance from it by a series of "sets," or booms, abutting against the bank. At the up-stream end of the raft was a large barge fitted up as a blacksmith's shop, for the necessary repair of the tools, with dwellings for the watchman, the ganger, &c. The bows of the barge were strongly fortified, and a strong oblique boom of large baulks reached from it to the shore, so as to protect the whole fleet from the craft coming down the river. At the down-stream end was another barge, fitted up as a powder magazine and as a shop, furnished with every necessary for the manufacture of the cartridges and for the storing of their material. The words "powder magazine" in large letters were painted on both sides of this vessel.

The first operation consisted in placing and securing in their proper positions, the pipes through which the holes were to be bored. Small stakes, painted with a series of numbers, were first driven into the bank, parallel to the work, at distances of 6 feet apart; as far behind them as the slope would allow, was another row of stakes parallel with the first, so that a line drawn through two stakes would be at right angles with the river, and a person standing behind the two stakes could readily direct the workmen when to lower the charge-pipe, which was then secured in its place, in the opening of the raft, by a "timber dog," driven into the raft on each side of it. The pipes were of wrought iron, drawn for the purpose by Messrs. James Russell and Sons, of Wednesbury: they were 3½ inches in diameter, $\frac{3}{16}$ths inch thick, and 9 feet long.* Two collars, half inch square, were shrunk on them near the upper end, for the purpose of retaining a rope, by which they were secured when the charge was fired. When the depth of the water increased, these pipes could be lengthened 4 feet by an additional piece, prepared for that purpose; this joint was made by shrinking on a collar, 6 inches long, over the joint. The pipe being in its place, was driven through any gravel that might remain and a few inches into the marl. The gravel was generally so thick upon the marl, that it was requisite first to remove it by means of the dredging machine. To protect the thin edges of the pipes whilst being driven, a cast iron cap, or plug, was used, which received the blows from a heavy wooden beetle; the interior of the pipe was next cleared of any sand, or gravel, that might have entered while putting them down. The principal tool used for this purpose was an iron bucket or cylindrical tube, 2 feet in length, of as large a diameter as would pass down the whole; it was furnished at the bottom with a valve opening inwards, and was jointed to a round rod, of the requisite length, half an inch in diameter, and when used with a pumping motion, quickly brought up whatever could not enter at the valve.

The boring then commenced; a gang of three men being stationed at each pipe. The first operation was that of the jumper, which was made with a single steel edge, a little rounded. The jumpers were of round iron, 1⅛ inch diameter, except 2 feet in length at the lower end, which was 1¼ inch diameter. For general use they were 15 feet long, and weighed about 52 lb. each; after working them till they were nearly set fast, an auger was inserted to raise the plug of loosened marl and to render the hole true. The shell of the auger was 20 inches long and nearly closed up, the better to retain the loosened borings.

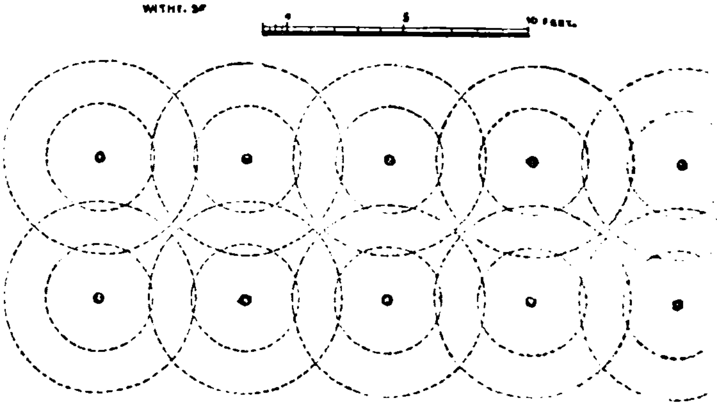
The shot holes were bored two feet below the proposed bottom of the dredging, as it was expected that each shot would dislocate, or break into small pieces, a mass of marl of a conical or parabolic form, of which the

Fig. 1.



Horizontal line shows depth of dredging.

Fig. 2.



* Where the marl was so deep as to require 8 or more pounds of powder, it was found that the cartridges of such diameter as could be used in these small bores were so long as to lose part of the effect of the gunpowder; subsequently, pipes of 4 inches diameter were used with advantage.

bore hole would be the centre, and its bottom the apex, so that four adjoining shots would leave between them a pyramidical piece of marl, where the powder would have produced little or no effect. By carrying the shot holes lower than the bottom of the intended dredging, the apex only of this pyramid was left to be removed, and in practice this was found to form but a small impediment (figs. 1 and 2). A second reason was, that if the removal of the shoals should cause the level of the summer water to fall lower than was expected, the marl might still be found sufficiently broken, to enable a greater depth to be obtained without further blasting.

The cartridges, or charges, were formed of strong duck or canvas bags, somewhat tapered at the bottom; these were filled with the required charge of powder, varying from 2 lb. to 4 lb., according to the depth of the marl;* the end of a coil of Bickford's patent fuse was inserted to the centre of the powder, and the neck of the bag was carefully gathered up round the fuse, and well tied with small twine. If the cartridge was small, it was then dipped into melted pitch, which had about one-fourth of tallow melted with it, or otherwise the melted pitch was ladled over it, till it was uniformly coated; in this state, the cartridges were hung to drain and stiffen. When hard, they were well rubbed over with tallow, and lastly powdered over with dry whiting. The tallow, whilst it insured the stopping of any little cracks in the pitch, facilitated the passage of the cartridge down the hole; the whiting also prevented the pitch from adhering to anything. It has already been stated, that the powder was ignited by means of Bickford's patent fuse; but as this material is never made in lengths exceeding 48 feet, it was found expedient, in order to save waste, to use the whole coil, cutting it off at the requisite length when absolutely in the hole, and using the remainder in the same way till the whole was used up.†

The charge was carefully pushed down into the hole by a wooden ramrod of suitable diameter, with the end rounded; the same instrument was used for ramming down the tamping. The material found to answer best for this purpose was the small fragments of hard marl, separated by the action of the weather from the lofty escarpment at each of these shoals; this was gradually filled into the holes, and rammed solidly, till the bore was full up to the surface; the timber dogs which held the pipes were then removed, the pipes were loosened from the marl, ropes were attached to the pipes and to the raft, or to some loose pieces of timber, and the shots were fired. Generally there was little external effect beyond the pipes being lifted a few inches, though sometimes they would be blown up several feet, and occasionally the water would be forced up through the pipe to a height of 40 or 50 feet. All the gangs commenced their holes in the morning, and they were generally all ready to fire at the same time, which was always done, as it caused least interruption to the work.

It was a rare occurrence for a shot to miss fire—probably not once in a hundred shots; the failure arising generally from a leak at the joint between the fuse and the bag. If the leak was not very serious, the shots were often saved by the following somewhat singular expedient. An iron bar, ⅜ inch in diameter and of sufficient length, pointed at the end, was kept in readiness, and when required the end was heated red hot, put quickly through the water into the tamping, through which it was driven as rapidly as possibly into the powder, which in nine cases out of ten it was still hot enough to ignite.

The result of the whole work being invisible, great care was necessary in order to prevent mistakes and omissions. As each shot was ignited, a red mark was laid against its corresponding stake upon the bank; when it had gone off, each shot was carefully examined with a steel chisel-pointed searcher, to prove that the required effect had been produced to the determined depth; when so found, the red mark was inserted into the top of the stake, as a certificate of that shot having passed examination; the numbers so certified were then transferred to a book kept for that purpose, and if a shot was found ineffective, another was put in the same place.

To afford space for the workmen, every alternate hole was first made, and afterwards those which had been left between them; one line being completed, the whole line of raft was moved 6 feet outwards to the next line, and so on till the required width was obtained. The whole establishment was then dropped down the length of the rafts, and the process was repeated. When the men had become used to the work, each gang would sometimes get down four shots per day, to that with fifteen gangs sixty shots have been fired per day.

It may be objected to the use of the patent fuse, that the ignition of a number of charges simultaneously by the galvanic battery would have produced better effect, at less cost, and in a more scientific manner. The author commenced the work under a different impression, and subsequent experience with the battery has not altered his opinion. When it is required to separate a large stone from its bed in the quarry without breaking it, nothing can be better than the numerous simultaneous discharges, which can only be obtained by the use of the battery, but the object in this work, on the contrary, was to break the mass to pieces as much as possible, which it is conceived would be more likely to be effected by distinct discharges.

Then as regards cost: the patent fuse No. 3, carriage included, cost $\frac{6}{10}$ths of a penny per foot; if the average length is taken at 15 feet, that is just nine-pence per shot, a sum which would barely pay for making the arrangement of wires necessary for the galvanic ignition. It was also found, from the compressible nature of the canvas cartridges, that the arrangement of the wires was very liable to be disturbed, during the insertion of the cartridge into the hole, or by the subsequent ramming of the tamping. After considerable experience, therefore, and the use of nearly 100,000 feet of the patent fuse, the author feels that he is only doing an act of justice to the Messrs. Bickfords, in stating the perfect satisfaction which the use of their ingeniously manufactured material has afforded him, in the prosecution of the work now described.

There now only remains to be given the cost of the operation above described. The first cost of the establishment or plant, sufficient for 6 months' work, was £300. This includes the waste and use of timber, in the raft, stages, booms, &c., hire of barges, and cost of fitting them up for the work, cost of pipes for boring, iron and steel for tools, deducting estimated value when done with, sundry ironmongery, waste and loss of ropes and other small stores.

More than four thousand shots have already been fired, and in the six months, at a low computation, six thousand will have been fired. This number gives just one shilling per shot, as the proportionate share per shot of the cost of the plant; this would of course be much less if the work was to be continued.

The cost of labour per shot varies from 2*s.* 6*d.* to 4*s.*; this sum, however, must be understood to cover the wages of the whole establishment as under: Superintendent of the work.—Foreman and timekeeper.—Examiner of the shots.—Maker of cartridge and two assistants.—Carpenter.—Blacksmith and hammer man.—Labourers, some at 3*s.*; majority at 2*s.* 6*d.* and 2*s.* 9*d.*—Watchman.—Thus the total cost per shot is as under:—

	s.	*d.*
Use of material	1	0
Labour, average	3	3
Pitched bag	0	3
3 lb. of powder, at 5½*d.*	1	4½
15 feet of patent fuse	0	9
Pitch, tallow, twine, coals, &c., say	0	4½
	7	0

If, therefore, the shots are 6 feet apart, and an average depth of 3 feet is broken up, 4 cubic yards are prepared for dredging at the cost of one shot; or the cost of the whole operation is 1*s.* 9*d.* per cubic yard. Distances of 5 feet apart were used in some very hard shoals, and spaces of 7 feet were tried in some that were softer than usual; spaces of 6 feet apart, however, appeared to be generally sufficient.

ON THE CORROSION OF METALS.

Paper by R. Adie, of Liverpool, *read at the Institution of Civil Engineers.*

This communication is intended to give an experimental proof of the fact, that water saturated with common salt, preserves to a great extent, the surface of the oxidizable metals from corrosion by the joint action of air and water. From some trials upon metals placed beside water in closed glass tubes, it was shown that water, or water containing a saline solution, does not act as a corroding agent, without the aid of the oxygen of our atmosphere. The details of some experiments, made to ascertain the quantity of oxygen dissolved by water under different circumstances, showed that brine and some other saline solutions contain much less dissolved oxygen than sea or ordinary water, which was the fact that induced the trial of salt water as a preserver of iron. The object of the last set of experiments was to determine by trial, the rates of corrosion of metals in fresh water, sea water, and brine; the results of these show that sea water corrodes the quickest, fresh water less rapidly, and brine very much slower than either.

On the rate of action of brine, sea and fresh water, in corroding.

These experiments were made with weighed pieces of metal immersed in the three solutions under examination. Those which are compared together, were tried in every respect under similar circumstances, as to weight and surface of metal; size and form of vessel; quantity of water employed; light and temperature.

The experiments on zinc were made with that metal in connexion with a piece of copper, so as to form a galvanic couple; for zinc, when unconnected with a less oxidizable metal, is soon covered with a crust of oxide, so that pieces, after a month's immersion in water, are found to be slightly heavier than at the beginning of the experiment. This is not the case when a piece of silver or copper is in metallic connexion with zinc; for then the white oxide of the metal is gradually precipitated to the bottom of the containing vessel.

A plate of zinc, 1 superficial inch in area, immersed for 60 days in sea water . . .	lost 1·0 grains.
A similar experiment in fresh water . .	„ 1·15
A plate of zinc, 7 superficial inches in area, immersed for 90 days in fresh water . . .	„ 4·9

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* The weights of powder used for depths of 4 feet, 4 feet 6 inches, and 5 feet, were respectively about 2 lb., 3 lb., and 4 lb.

† The short remaining ends, though useful for less depths, were of little value, from the difficulty of splicing them together. This operation, though troublesome, was resorted to with success on one occasion whilst waiting the arrival of a parcel of fuse. On returning the short ends to Messrs. Bickford they allowed half the length of new fuse in exchange.

A similar experiment in brine, or the saturated solution of common salt tested as above for dissolved air	„ 1·4
Wrought iron wire:—	
Twenty pieces of iron, weighing 374 grains, immersed for 80 days in fresh water . .	lost 1·9 grains.
A similar experiment in sea water . .	„ 2·6
A similar experiment in brine . .	„ 0·1
Cast iron:—	
Three rods of cast iron, weighing 787 grains, immersed for 62 days in fresh water . .	lost 1·6 grains.
A similar experiment in sea water . .	„ 2·0
A similar experiment in brine . .	„ 0·4

On comparing together the loss of weight of metal in the fresh water, sea water, and brine, it will be observed, that in sea water the corrosion is about one third more than in fresh water; while in brine, the loss of weight is about one-fourth part of the loss in fresh water, and one-fifth part of that experienced in sea water; showing that brine possesses considerable power for preserving metals from corrosion. The carbonates of potash and soda are still more effectual in arresting oxidation; for in saturated solutions of these salts, iron wire remained immersed for sixty days without any amount of corrosion being detected. The surface of the plate of zinc, when taken from the brine, was the same as at the commencement of the experiment, excepting in three spots, where there was deep corrosion. The principal of these being around the point, where the copper wire connected the plate with the negative element. The difference shown between fresh water and sea water, in their power of oxidizing metals, is in the reverse order of the quantities of oxygen dissolved by them, as given in the preceding experiments; where the sea water is to the fresh as 78 to 85. The principle on which the preserving power of alcohol is attempted to be explained may, in like manner, be here applied to pure water. Although the experiments on the corrosion of iron were continued for eighty days, the difference between the action of common water and brine may be made apparent in one day. In the fresh water, the hydrated peroxide of iron is seen forming; while in the brine, only a slight tinge of a greenish infusion can be detected, a sure indication of the scarcity of oxygen.

The experiments given to determine the respective rates of corrosion in fresh and sea water, are only correct for pieces of metal wholly immersed in them. Where the surfaces are subject to be wet and dry, the corrosive effect of sea water will greatly increase; on the same principle that iron once coated with rust, decays much faster after the rust has provided a lodgment for moisture. Take for example a bar of iron in a field, and a similar piece on the deck of a ship. On the first, the dew of night deposits water, which corrodes until the return of the sun dries it all off. On the second, on the deck, it deposits spray, which acts like the dew, until the sun dries it off; but when dried, there is left a thin deposit of salt, with a powerful affinity for moisture, which on the return of evening will attract moisture from the atmosphere, long before the dew wets the metal in the field. Thus it is that a coating of salt or rust, keeps metals much longer in a wet state, than if their surfaces were clean.

Remarks.—The experiments which showed that brine (by which term, he supposed, a saturated solution of common salt in water was meant) should be found to be less corrosive of iron than sea water, was consistent with the circumstance, that less air was contained in water which was saturated with any solid substance, than was contained in water only slightly impregnated with such substance, and there was no doubt, but that the atmospheric air performed a principal part in the oxydation of iron, which was exposed to the weather. Air containing water in solution, corroded iron rapidly; and water containing air in solution did the same; and alternate exposure of iron to water and to air, corroded it still more rapidly; particularly when by the warmth of the sun, and the blowing of the wind, the film of water which was left on the surface of the wetted iron was evaporated, or dried away from that surface, before a fresh wetting occurred. Perfectly dry air was very slightly, if at all, corrosive of iron, and water completely freed from air by boiling, was not actively corrosive, in the manner that air and water were. Respecting salt, there was nothing corrosive of iron in its own nature; it contained no oxygen, but although it was a great cause of corrosion of iron, the corroded iron was found to be an oxide, not a muriate of iron. The salt when dissolved in water, greatly increased the corroding effect upon iron which was immersed in the salt water, and still more if the iron was frequently wetted, or washed with salt water and dried by the sun and the wind, in the intervals between successive wettings. The concurrent effect of air, water and salt, was extremely corrosive of iron. It was well known, that dry salt was not at all corrosive of iron, for in stoves for drying salt, the flues were frequently made of iron plates, and the salt in lumps being laid directly upon the iron, did not corrode it at all, the iron being always kept hot and dry; in the same stoves, if they were not used, and allowed to cool, the salt absorbed humidity from the air, and became very corrosive of the iron work. Iron salt-pans, for boiling brine, did not become oxydated as rapidly as might be expected; indeed, they were scarcely affected at the parts of the upright sides of the interior surface of the pans, which were always beneath the surface of the hot brine and were not exposed to the action of fire. The manner in which salt operated, to increase the oxydation of iron, was probably by an electro-chemical action, the chief part of the oxygen which the iron absorbed, being derived from the atmospheric air, the other part from the water, and none from the salt. In heaps of old iron exposed to water, it might be observed to lodge in the hollows, and to occasion rapid rusting of the iron, attended by a smell of hydrogen, and a thin pellicle floating on the surface of the water, showing dingy prismatic colours. The paper which had been read, mentioned absorption of oxygen from the air by water; it was generally understood, that when water absorbed air from the atmosphere, the nitrogen of the air, as well as the oxygen, were both absorbed together by the water, in their accustomed proportions, as they existed in the atmosphere, so as to be an absorption of atmospheric air by the water.

Mr. Lowe said the paper led to the consideration of the change which was induced in cast iron, by continued immersion in various fluids. This had been frequently discussed at the Institution, and it would be desirable if Mr. Adie would continue his experiments, with a view to elucidating that question, as the conversion of cast-iron into carburet of iron, or graphite, appeared, under certain circumstances, to be so rapid, as to have rendered necessary the substitution of other and more expensive metals. In breweries, for instance, the change had been produced so very speedily, wherever the acid wash came into contact with metal, that copper gratings had been of necessity substituted for cast iron.

Sir John Rennie, President, stated, that the earliest example in his recollection of the change produced by sea water in cast iron, was in some iron guns which were fished up in 1822 off Holyhead. They were supposed to have belonged to a pirate vessel which was destroyed there about 100 years previously. When found they were quite soft, but after exposure to the air for a time, they became so hard, that they were used to fire salutes, when George the IVth passed through Holyhead, on his way to Dublin, and it was remarked that the report from them was louder than from any other iron guns of a similar size.

REVIEWS.

Turning and Manipulation. By Charles Holtzapffel, Vol. II. Illustrated by upwards of 700 woodcuts. Holtzapffel. London: 1846. 8vo.

This large octavo volume of upwards of 500 closely printed pages, is only one of a series of six, in which the subject of Mechanical Manipulation is intended to be comprised. The first volume (reviewed, *ante*, vol. VI, p. 1843), treated of the properties of various materials used in the arts, and their preparation, &c. The present volume describes the various kinds of cutting tools used by the hand, such as boring tools, saws, and planes, and their modification when worked by steam-engine power. The third volume will refer to abrasive processes, such as grinding and polishing; the fourth to simple hand turning; the fifth to complex turning; the sixth to amateur mechanical engineering. It is intended that the first three volumes should form a general preliminary work with an index in common.

The volume before us is of so thoroughly technical a nature, and affords the most minute and practical information on the subjects of which it treats; at the same time, it is written and arranged in a very perspicuous manner, and abounds with interesting accounts of successive improvements of different machines, the extraordinary perseverance and skill of the mechanicians to whom these improvements are due, and the beautiful accuracy of their final results. While therefore the chief value of this work will be the practical guidance which it affords respecting peculiar classes of industrial art, it has also an interest for the general reader, and especially to the engineer pursuing some branch of his profession collateral to that here considered, because it exhibits to him the important mutual dependence of the arts to each other. The introductory chapter (the 22nd of the work) gives general remarks on cutting tools, the variations of the cutting angle of the tool, (that is the inclination of the surfaces meeting at its edge) and the variations of the angle of inclination to the material to be cut, which of course depend on the hardness of the material.

In the next chapter the plane and planing machine and their modifications are described, together with a great deal of minute information about joiners' benches, bench stops, adjustment of bench planes, and other mysteries of the workshop. The subsequent chapter treats of turning tools for hard and soft woods, ivory, brass, iron, and steel, and the manipulation of these instruments. Next comes a chapter on drills of all kinds, watch drills, press drills, ratchet and lever drills, corner drills, differential screw drills, &c. The following chapter is a most interesting one upon cutting machines, and traces the construction of the screw from the simple method invented by Pappus to the most refined processes of modern art. The four following chapters are devoted to saws, files, shears, and punches, respectively, and the application of those instruments on a large scale by steam or other engine power.

We offer the following extract from the chapter on screws, of an account, which we have ourselves read with great interest, of the successive improvements in the manufacture of the screws. The great difficulty is to make the inclination of the thread uniformly regular, and the extraordinary and microscopical accuracy which has been attained in this respect may be considered among the most admirable triumphs of practical science. The ingenuity, skill, and perseverance of the mechanicians engaged in this pursuit can be but little known to general readers.

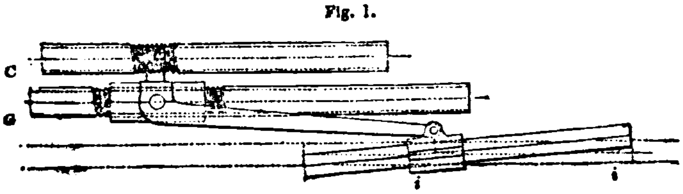
"The late Mr. Henry Maudslay devoted an almost incredible amount of labour and expense, to the amelioration of screws and screwing apparatus; which, as regarded the works of the millwright and engineer, were up to that time in a very imperfect state. With the view of producing screws of exact values, he employed numerous modifications of the chain or band of steel, the inclined knife, the inclined plane, and indeed each of the known methods, which however he remodelled as additions to the ordinary turning-lathe with a triangular bar; a natural result, as he was then in the frequent habit of constructing that machine, and which received great improvement at his hands.

"It was noticed at page 581, that of all the methods he gave the preference to the inclined knife, applied against a cylinder revolving in the lathe, by means of a slide running upon the bar of the lathe; which besides being very rapid, reduced the mechanism to its utmost simplicity. This made the process to depend almost alone on the homogeneity of the materials, and on the relation between the diameter of the cylinder and the inclination of the knife; whereas in a complex machine, every part concerned in the transmission of motion, such as each axis, wheel and slide, entails its risk of individual error, and may depreciate the accuracy of the result; and to these sources of disturbance, must be added those due to change of temperature, whether arising from the atmosphere or from friction, especially when different metals are concerned.......... The relations between the guide-screw and the copy were varied in all possible ways: the guide was changed end for end, or different parts of it were successively used; sometimes also two guide-screws were yoked together with three equal wheels, their nuts being connected by a bar jointed to each, and the center of this link (whose motion thus became the *mean* of that of the guides) was made to traverse the tool. Steel screws were also cut, and converted into original taps, from which dies were made, to be themselves used in correcting the minor errors, and render the screws in all respects as equable as possible. In fact, every scheme that he could devise, which appeared likely to benefit the result, was carefully tried, in order to perfect to the utmost, the helical character and equality of subdivision of the screw.

"Mr. Maudslay succeeded by these means, after great perseverance, in making a very excellent brass screw about seven feet long, and which, compared with standard measure, was less than one-sixteenth of an inch false of its nominal length. Taking the error as the one-thousandth part of the total length of the screw, which was beyond its real quantity, to make from it a corrected screw by the system of change wheels, would have required one wheel of 1000 teeth, and another of one tooth less, or 999; but in reality the error was much less, and perhaps nearer the two-thousandth of an inch; then the wheels of 2000 and 1999 teeth would have been required; consequently the system of change wheels is scarcely applicable to the correction of very minute errors of length.

"The change of the thousandth part of the total length, was therefore given to the tool as a supplementary motion, which might be added to, or subtracted from, the total traverse of the tool, in the mode explained by the diagram, fig. 1, in which all details of construction are purposely omitted. The copy C, and the guide-screw G, are supposed to be connected by equal wheels in the usual manner; the guide-screw carries the axis of the bent lever, whose arms are as 10 to 1, and which moves in a horizontal plane; the short arm carries the tool, the long arm is jointed to a saddle which slides upon a triangular bar *i i*.

Fig. 1.



"In point of fact, the tool was mounted upon the upper of two longitudinal and parallel slides, which were collectively traversed by the guide-screw G. In the lower slide was fixed the axis or fulcrum of the bent lever, the short arm of which was connected by a link with the upper slide, so that the compensating motion was given to the upper slide relatively to the lower.

"The triangular bar *i i*, when placed exactly parallel with the path of the tool, would produce no movement on the same, and C and G would be exactly alike; but if *i i*, were placed out of parallelism one inch in the whole length, the tool, during its traverse to the left by the guide-screw G, would be moved to the right by the shifting of the bent level, one tenth of the displacement of the bar, or one-tenth of an inch.

"Therefore whilst the guide-screw G, from being coarser than required, moved the principal slide the one-thousandth part of the total length in excess; the bent lever and inclined *straight* bar *i i*, pulled back the upper or compensating slide, the one-thousandth part, or the quantity in excess; making the absolute traverse of the tool exactly seven feet, or the length required for the new screw C, instead of seven feet and one-sixteenth of an inch the length of G. To have lengthened the traverse of the tool, the bar *i i* must have been inclined the reverse way; in other words, the path of the tool is in the diagram the *difference* of the two motions; in the reverse inclination, its path would be the *sum* of the two motions, and *i i* being a straight line, the correction would be evenly distributed at every part of the length.*

"Whilst Mr. Maudslay's experiments in perfecting the screw were being carried on, his friend Mr. Barton†, paid frequent visits to his manufactory, and also pursued a similar course. Mr. Barton preferred however, the method of the chain, or flexible band for traversing the tool the exact quantity; because the reduction of the diameter of the pulley or drum afforded a ready means of adjustment for total length; and all the wheels of the mechanism being individually as perfect as they could be made, a near approach to general perfection was naturally anticipated on the first trial. This mode, however, is subject to the error introduced by the elasticity or elongation of the chain or band, and which is at the maximum when the greatest length of chain is uncoiled from the barrel.

"These two individuals having therefore arrived, by different methods, as near to perfection as they were then respectively capable of; each made a screw of the same pitch, and 15 inches long, and the two when placed side by side were found exactly to agree throughout their length, and were considered perfect. The two screws were submitted in 1810 to the scrutiny of that celebrated mathematical instrument maker, the late Mr. Edw. Troughton, F.R.S., &c., who examined them by means of two powerful microscopes with cross wires, such as are used for reading off the graduations of astronomical instruments; applied like a pair of the most refined compasses, to measure the equality of some 20, 50, or 100 threads, taken indiscriminately at different parts of the length of the screws.‡ From this severe trial it resulted, that these screws, which to the unassisted sight, and for almost every purpose of mechanism, were unexceptionable, were found to be full of all kinds of errors, being unequally coarse at different parts, and even irregular in their angles, or "drunk." This rigid scrutiny led both parties to fresh and ultimately successful efforts, but of these our limits will only allow us to notice one, apparently derived from the use of the *two* microscopes.

"Mr. Barton employed *two* pairs of dies upon the one screw; the dies were fixed at various distances asunder upon one frame or bar, and the screw was passed through them. This was found to distribute the minute errors so completely, that little remained to be desired; as it is obvious that at those parts where the screw was too coarse, the outer sides of the threads were cut, and which tended to shorten the screw; and where it was too short, the inner sides were cut, which tended to lengthen the screw; in fact the two parts temporarily situated within the dies, were continually endeavouring to approximate themselves to the fixed unvarying distance, at which the dies were for the time placed.

"Mr. Barton informed the author that he employed the screw corrected in the above manner, in his engraving machine, employed for cutting with the diamond, the lines as fine as 2000 in the inch, on the steel dies referred to in the note on page 42, vol. i.; and he said 'that such was the accuracy of the mechanism, that if a line were missed, the machine could be set back for its insertion without any difference being perceptible.' The author unintentionally ascribed the first application of the diamond to turning steel, to Sir John Barton, whereas it had been used long before by Ramsden in cutting the hardened-steel screw for his rectilinear dividing engine."

These adjustments and corrections, almost perfect as they would seem to be, have been subjected to still further refinement. One of the most beautiful mechanical devices which we have ever met with is described in the subdivision relating to the application of the screw to the *graduation of mathematical scales*.

"One very important application of the screw, is to the graduation of mathematical scales, the screw is then employed to move a platform, which slides very freely, and carries the scale to be graduated; and the swing frame for the knife or diamond point is attached to some fixed part of the framing of the machine. Supposing the screw to be absolutely perfect, and to have fifty threads per inch, successive movements of fifty revolutions, would move the platform and graduate the scale exactly into true inches; but on close examination, some of the graduations will be found to exceed, and others to fall short of the true inch.

"The scales assume, of course, the relative degree of accuracy of the screw employed. No test is more severe; and when these scales are examined by means of two microscopes under a magnifying power of ten or twenty times, the most minute errors become abundantly obvious, from the divisions of the scales failing to intersect the cross wires of the instrument; the result clearly indicates, corresponding irregularities in the coarseness of the screw at the respective parts of its length. An accustomed eye can thus detect, with the microscope, differences not exceeding the one thirty-thousandth part of an inch, the twenty-five-thousandth part being comparatively of easy observation.

* The apparatus was fitted to the second screw-lathe of those described, and the inclined bar was placed on temporary wooden standards.

† Subsequently Sir J. Barton, Comptroller of the Mint, &c.

‡ The microscope had been long used in the process of graduating instruments, but this invaluable mode of employing two microscopes in combination, was first successfully practised by Mr. Troughton.

"From Mr. Donkin's investigation of the subject, he was led to conclude that it is quite impossible to produce a screw which shall be absolutely free from error, when micrometrically proved; and in 1823, he was in consequence led to consider that as Mr. Maudslay's method of the bent lever and inclined *straight* bar, would compensate the error of total length in a nearly perfect screw, a similar mode might be applied to all the intermediate errors, by the employment of a *curve*, experimentally obtained by the method of continual bisection employed in hand dividing.

"It having been explained in reference to the diagram,* that the inclination given to the bar would reduce the effective length of a screw, and the reverse inclination would increase it, Mr. Donkin considered that from the observed fact of one half of the screw (as estimated by counting the number of threads) being generally too coarse, and the other half too fine, the compensation would require the one half of the bar to be inclined to the right, as in the diagram, and the other half to the left; in fact, thus bending the right line into an obtuse angle.

"Extending this mode, upon the presumption that the quarters, eights, or sixteenths of the screw were also dissimilar, the bar would require many flexures instead of the one only, giving to it a more or less zig-zag character, or rather that of a gently undulating line. The undulations being proportioned *experimentally*, to effect such compensations, as should *add* to the movement of the upper platform or supplementary table, where the screw was too fine, and *subtract* from its motion, where the screw was too coarse; so as, from a screw known to be slightly irregular, to produce the divisions of a scale, or the thread of another screw, considerably nearer to equality.

"He carried out this project in 1826, and he has satisfactorily proved the existence of a correctional method, which is within reach of any clever workman who will devote sufficient *patience* to the adjustment of the engine, and which latter will be now briefly explained........To effect the compensation, the platform or table consists of an upper and lower plate, which are capable of a small independent motion. The lower plate carries the fulcrum of the bent lever, whose arms are at right angles and as fifty to one, the lever moves in the vertical plane, so that its longer arm lies by gravity alone on the curvilinear edge of the compensation bar; the upper platform is pressed endlong against the shorter arm of the bent lever, by a spring which always keeps them in close contact.

"The compensating bar, which is of the length of the screw, or 24 inches, has 48 narrow slips of metal placed like the keys of a piano-forte, each having an appropriate adjusting and fixing screw, by which the ends of the pieces may be placed in a continuous line, or any of them may be placed above or below the line, as required in the following mode of compensation. For change of total length and adjustment for temperature, the curved bar is more or less inclined, as in the former example, except that it is placed edgeways or vertically; it is attached to the outside of one of the rails, by a pivot which intersects the one end of its curvilinear edge, and the other end is raised or depressed by a screw, which effects the adjustment for temperature.

"Conceiving the length of the guide-screw divided into 48 equal parts, denoted by the figures 0 to 48, it would be first ascertained by two fixed microscopes, if the halves of the screw, measured from 0 to 24, and from 24 to 48, were absolutely equal quantities; if not, the central slip or finger would be raised or lowered until on repeated trials the due correctional movement was applied to the table. The two halves would be similarly bisected and corrected in the points 12 and 36, and the quarters again bisected in 6, 18, 30, and 42; and the eighths when also bisected, would extend the examination to the points 0, 3, 6, 9, &c., to 48. The easiest method is to compare the path of the slide, with the divisions of a superior scale, fixed upon the slide or platform of the machine.

"It would now be needful to divide the whole into three parts, by the comparison of the spaces from 0 to 16, from 16 to 32, and from 32 to 48, the points 16 and 32 being adjusted until exactly equal, which is the most difficult part of the work; and then these three distances being bisected four times, every point of the 48 would have been examined, and some of them twice over. These adjustments having been repeatedly verified, during which a very frequent recurrence to the total length is imperative the concluding step is to file off the corners of the 48 slips very carefully, so as to convert them into a line with undulations, slight it is true, but which represent fifty-fold the actual errors in the guide-screw; and therefore shift the table simultaneously with its general traverse, so as to apply the exact corrections for inequality, at every point examined and found to be in error.

"But the term *error* must be received in a very restricted sense, as it deserves to be noticed that Mr. Donkin first used a screw made by Mr. Maudslay, and the maximum deflection of the curved edge of the compensation bar from a straight line was very nearly the *eighth* of an inch, indicating the maximum *error* of the screw to have about the 400th part of an inch; and as the curve was nearly limited to a single undulation, or a hill at one end, it may be presumed this minute error was in part attributable to a difference in the material, a source of perplexity from which no care is a sufficient protection. The dividing engine was employed as a traversing lathe in cutting a new screw, and which, although it had the advantage of the compensation, only reduced the error of the new screw to about one-third the quantity of that of the first; as shown by the new curve assumed by the compensation bar, its deflection being $\frac{1}{24}$ of an inch, when re-adjusted in the tedious and anxious method described.

"In the past year, 1842, Mr. Donkin has made a similar but enlarged dividing engine. The length of traverse of the new machine is 42 inches, the screw has 40 threads to the inch, the compensation bar is as 60 to 1, and the value of one single tooth in the counting wheel is equivalent to the 60,000th part of an inch; that of the first machine having been the 30,000th part. It is to be hoped that Mr. Donkin will complete his labours, by publishing a detailed account of these machines, the latter of which, in particular, exhibits throughout its structure a most refined contrivance and execution, of which no adequate idea can possibly be conveyed within the limits of this slender notice, nor without exact drawings of the details, to the arrangement of which great attention has been bestowed."

* Given in the last extract.

The work is in plan one of the most extensive of all those which form the literature of practical science, and forms an invaluable addition to it. We may probably again refer to it. There are two papers by Professor Willis; we should like to know whether they have been originally communicated to this work, or are merely reprinted. They are inserted without any introduction.

The Assistant Engineer's Railway Guide in Boring, &c., preceded by Practical Memoranda on Specifications. Illustrated by 60 woodcuts and plates. By W. Davis Haskoll, Civil Engineer. Williams, Strand, 1846. 8vo. pp. 136.

So many books are now published on various branches of the practice of railway engineers, that we naturally look to the commencement of each new publication to learn the author's specific object, and how his production differs from the rest of its class. The present work has not, however, any preface or introduction: it indicates as far however as may be learned from the title of the book, and an examination of its contents, Mr. Haskoll's object has been to set before the assistant engineer a concise, but at the same time, explicit directions for his guidance, in examining the progress of a railway, and in ascertaining that the contractors' work is satisfactorily performed. The first, and one of the most useful chapters, gives an abstract of the clauses which ought to be contained in a specification for the construction of a railway, and the general conditions of contracts. The next chapter treats of railway borings, and about one-fifth of the whole work is occupied by a full account of the tools and operations requisite in boring to ascertain the nature of the strata which a railway traverses; this chapter concludes with an account of the economic properties of various kinds of English building stones. The third chapter treats of the methods of setting out the centre line and curves of a railway. This is followed by minute directions for setting out slopes, making land plans, &c. The fifth chapter explains the method of setting out foundations, and affords some hints which will be very valuable to those engaged in over-looking the construction of brick arches and masonry. Mr. Haskoll gives a very bad account of bricklayers. They seem a slippery set of fellows, and require as much watching as horse-dealers.

The general directions for securing firm foundations are good in themselves, but not perhaps sufficiently extended: instead of referring to other works, such as Hughes's papers on Foundations, Godwin on Concrete, Vicat on Cements, and papers in the "Civil Engineer and Architect's Journal," the author might have furnished a useful collation of information from those sources. At the end of the book are a table of gradients, and that most valuable appendage—a good index. The arrangement of the book is very clever; the paragraphs are numbered and reference to them is greatly facilitated by the frequent marginal references which occur on every page. The author has saved the student much trouble by bringing together a great deal of information, scattered about different publications, and his task is performed in a successful manner.

The following is, with some omissions, the abstract of the clauses which, ought to be contained in a specification drawn up on the part of railway company, for the direction of contractors. For precedents of the general conditions of contracts, the author refers to those of Stephenson, Brunel and other engineers, in Brees' Railway Practice. The perusal of the extract below will give to the student a good general idea of the practice of railway construction, and of the points to be attended to in overlooking the progress of the works.

"Strong general clauses in a specification are unjust and arbitrary towards a contractor, where they are only intended to shelter an engineer from neglectful omissions, and from due responsibility, and where full and particular explanations and instructions are not given, for the construction of the various works, as they occur along the different contracts. But where they refer to the manner of the work, general workmanship, to the kinds and qualities of materials, unless otherwise specified in particular place, they cannot be objectionable. General conditions to contracts should be added to protect companies from trouble and annoyance, resulting from the depredations and reckless conduct of workmen, times of payment, restrictions from neighbouring lands, and also for the protection of the workmen from fraud and tyranny; power to increase number of men, or to remove objectionable parties.

"The permanent fencing may consist of a brick wall, of which materials, dimensions, footings should be given, by drawings figured; and whether set in mortar or cement, or in part. Or it may consist of a rubble wall, set in mortar, with half hammer dressed coping, according to drawings and dimensions. Where thorough stones or borders are to be introduced, it should be mentioned, and the size of the stones limited, both for the walling and coping. Permanent fencing may also consist of a good set fence and ditch, with a row of posts and railing fixed on the outside, according to dimensions to be given. The posts and railing to be good oak or larch; the posts to be 6 inches square, or 6 by 3½ inches, 3 feet 6 inches out of the ground, and 1 foot 6 inches in the ground; that part below the ground to be well charred, and the posts to be from 7 to 9 feet apart.

"The soil underneath the cop must be carefully trenched over 12 inches deep, previously to the cop being formed; the cop must then be formed by a ramparting of sods on each side, and the intervening space filled with good vegetable soil; the cop must be planted in the months of October or November, February or March, with good white-thorn plants four years old, having been transplanted from the seed bed three years.

"The ditch to be 4 feet wide at the top, and 2 feet at the bottom, and 1 foot 6 inches deep; the depth of the ditch must be varied, so as to carry off all the water flowing from the embankments or adjoining lands, and proper communications must be made with each intersected drain, so as effectually to attain the desired object, and drains must be formed under the cop, at such intervals as may be requisite to carry of all the water from the foot of the embankments.

"If the engineer should deem it necessary to increase the width of the excavations or embankments, or to flatten the slopes, the contractor will be paid extra for increased quantities, unless it happen that there is excess of excavation, which would otherwise have to go to spoil, in which case the engineer may direct the embankment to be increased without the contractor being paid any extra sum, or, unless side-cutting be required, in which case the engineer may direct the excavation to be increased, and the contractor shall have no claim for so doing.

"At the proper season the slopes must be sown with rye grass or white clover seeds, at the rate of 2 bushels of the former to 6 pounds of the latter per statute acre.

"Whenever any change is made in the inclination of any of the slopes, it must be done gradually, and in not less than 25 yards in length, unless it occur at a bridge, in which case the inclination of the slopes may be different at each side of the bridge.

"During the progress of execution, great care must be taken to prevent water from settling in the excavations and embankments, and any means deemed fit by the engineer, must be resorted to in order to prevent it. A ditch or channel, 12 inches wide and 6 inches deep, must be formed along each side of the excavation, at the foot of the slope, to carry off the water; and if, in the opinion of the engineer, it should become necessary or advisable, in any one case, to put open drains, formed with rubble pitching and side walls, as shewn on drawing, the contractor shall be paid extra for such increase of work, according to the prices set forth in the schedule.

"In the event of any soaks, springs or streams of water appearing from the face of the slopes or otherwise, the contractor must, at his own expense, effectually drain the same, by means of drains or water courses, of rubble or brushwood, put in such manner, and to such extent, as the engineer shall deem expedient from time to time, to prevent such soak, spring, or stream, from injuring the works during progress, and the whole of such water shall be conveyed into proper drains.

"Whenever the seat of an embankment occurs on side-long ground, the same must be cut out in steps, sloping inwards towards the embankment, and the material punned so as to prevent the embankment from slipping. Should the seat of the embankment be peat or other soft material, deemed by the engineer unfit to bear the weight, the contractor shall, at his own cost, and according to instructions from the engineer, remove the same, or cut out a trench, 10 feet wide, entirely through the peat, under the foot of each slope, and fill up the same with good dry material, to be approved of, carrying it 6 feet above the surface of the ground previously to the embankment being tipped on it.

"In bringing an embankment over any bridge, or culvert, the greatest care must be taken to prevent any unequal loading; and any damage caused by neglecting this precaution must be made good by the contractor at his own cost. In the case of culverts with side walls, a space of 10 feet on each side, and over the top, must be punned to a height of 8 feet above the culverts, and no greater height of embankment must, in any case, be allowed to be tipped against or upon the culverts than the height already laid upon the culverts. In the case of crossing of bridges in embankments, the earth must be punned in each case, for such a space as the engineer may deem requisite, in no case being for a less space than 10 feet from the abutment or wing wall, and the material must be conveyed across the bridge by means of baulks of timber laid so as to enable each side to be embanked equally at the same time.

"Where the building of bridges may interfere with the traffic of roads, and previous to any bridge works being commenced, a proper well-made temporary road shall be prepared and made, which must be sufficient for the free passage of carriages of all descriptions. The contractor must take every precaution during the alteration, to erect proper fencing, fix lights, and have a night watchman to prevent accidents, as the company will not be liable for any injury arising from any neglect of these precautions on the part of the contractor.

"The bricks made use of shall be hard, sound, well shapen, thoroughly burnt, and of uniform size, and unless made a year before they are used, must be well saturated with water. No broken bricks will be allowed, except where required as closers; and, in case of backing, the whole must be flushed up perfectly solid with mortar, for which purpose, after the outside course is set, the mortar must be laid on the interior space, and water being poured on must be worked about until every joint is filled perfectly solid. The whole must be built in old English bond, that is, in alternate courses of headers and stretchers, and in case of thick walls, every third and fourth course of the interior, must be laid a "Herringbone;" the face work must all be neatly jointed with a trowel, and struck with a straitedge. No face work will be allowed to be built over-handed; no four courses with three joints, must exceed in thickness, when built, three-quarters of an inch more than the same bricks measure when piled on each other without mortar.

"No brick work or stone work shall be set in frosty weather.

"All the stone used in the work should be sound, hard stone, free from shakes, clay holes, beds, or flaws of any description: if desirable, describe the quarry; it must be approved of by the engineer. No stone either in the inside or outside work should break joint less than 18 inches; the stones in the interior work should bond well with each other, and each course well grouted with lime.

"The ashler work shall lay in courses, not less than 12 inches thick, and with stones, not less than 4 feet by 2 on the bed, and laid alternately as headers and stretchers; all joints must overlap at least 12 inches. In all cases where the engineer may deem it advisable, the whole must be dowelled together with dove-tailed hard stone dowells, or cramped with iron.*

"The block in course shall be of stone laid in courses, not less than 7 inches thick, and each stone shall not be less than 12 inches by 18 inches on the bed, laid alternately as header and stretcher; and one-fourth the length of each course shall consist of stones not less than 30 inches in length, measuring from the face of the work to the interior, laid as nearly equidistant as possible so as to effect a perfect bond with the rubble backing.

"The rubble backing must consist of flat hedded stones, as large as can be obtained. The whole must be carefully pinned and made solid, laid in mortar, and cut to a level surface at every course of the face work; and after the next course of the face stones is laid, the interstices must be completely filled with thin mortar, the mortar being mixed with water, and worked about until every crevice is filled perfectly solid.

"When rubble is used for the entire work, both on the face and in the interior, the stones must be laid with great care so as to be perfectly bonded together; no stone must contain less than a cubic foot except when used only for pinning.

"Pier points will consist of flat bedded stones, cut into uniform sizes, not being less than 10 inches by 5 inches on the bed, and 3 inches thick; they will be used for turning the smaller arches.

"Where desired by the engineer in foundations, in parts below the surface of the ground, or under water, or parts exposed to wet, to any height desired, the mortar shall be made with hydraulic lime, of a quality that shall meet with the approbation of the engineer. No mortar which has set, or become hard, will be allowed to be used.

"The cement used shall be patent Lithige, or Earle's cement, or any other desired, but whichever be used shall be of the best quality, and shall be approved of by the engineer; it must not have more than one part of clean sharp sand to two parts of cement, and these proportions shall be accurately measured; the mixture shall be wetted only as required for use, and none shall be used that has set or hardened.

"The concrete must be composed of good coarse gravel, or broken stones, either being approved of by the engineer, with an admixture of good sharp sand. The gravel and sand must be mixed with lime, in the proportion of one part of the latter to six parts of the former.

"Stone arches will be of ashler, block in course, or pier points. The beds and joints of the stones must be worked to accurate planes, and the beds in the direction of the radii of the arch. The greatest care must be taken to cut the stone in the spandrils, so as to fit close on the extrados of the arch.

"In all cases where the arches are built askew, the courses must be in spiral lines, at right angles to the face of the arch.

"Pierpoint arches will be laid similarly to brick arches.

"Counterforts must be worked into the body of the arch, and the courses below the springing of the arch must all be parallel to the radius of the arch at the springing line.

"As soon as the weather will permit, or when the engineer may direct, the arch and backing shall be covered with coal tar. Or asphalte, properly prepared and approved of by the engineer, may be used for this purpose, which is to prevent water from sinking into the arch; and the contractor shall be held responsible that the arches, backing, and spandrils shall be made thus impervious.

"Above this coating of tar or asphalte, and, when ordered by the engineer, a coating of sand to the depth of 6 inches shall be laid, and above this, the space must be filled with shivers of stone laid with a regular sur-

* Though iron cramps are often used, they should not be resorted to without much consideration, as the corrosion of the iron is sure to rend the stone sooner or later, and where the iron is much exposed to atmospheric influence this will soon occur.

face, and lastly, a good road metalling, of a kind approved, of 8 inches thick, shall be laid, and the stones properly broken.

"Where stone imposts or springers are used, they must be equal to the full thickness of the arch, besides allowing for the projection, and no stone shall be less than 30 inches in length; where there is more than one arch, at least four stones on every pier shall extend across the whole breadth of the pier. In cases of skew arches, the skew back must be worked out, to suit the oblique direction of the courses.

"Openings must be left through the lower parts of all abutments, wing walls, and retaining walls, and dry rubble drains carried up at the back, in order effectually to prevent any water lodging behind the brick work or masonry.

"The abutments and wing walls shall be filled into and backed with chipping of stone, as far as they can be procured, clean dry gravel, or suitable material approved of by the engineer, and to be procured in the neighbourhood; as they are carried up, the filling and backing shall be well rammed with punning malts, in courses not exceeding eighteen inches thick.

"Culverts, under three feet in length, must be carried to the outside of the fencing. Culverts must be built to the necessary angle, and each culvert shall be so placed as to give a free and uninterrupted passage to the water; and whenever the position or direction of a culvert does not coincide with that of the existing course of stream, the course shall be altered to such extent as may be considered requisite by the engineer, to adapt it to the position of the culvert, by the contractor, at his own cost. They shall be built of materials to be approved of by the engineer, and such as will stand well in water, and shall be set in good hydraulic lime mortar. The site of culverts may be varied by the engineer.

"The foundations of viaducts, bridges, culverts, walls, and other works, must be excavated to such depth as the engineer may deem requisite, and no masonry or concrete must be put in until they have been examined and approved of by the engineer. All the water must be effectually kept out during the execution of the works by means of coffer-dams or pumps, or both, and the coffer-dam or pumps, or other machinery, to be provided by the contractor, and approved of by the engineer. If it is required to carry the foundations lower than shown on drawings, the contractor must execute such additional masonry, brick work or concrete, or piling and planking, according to the schedule of prices, being paid only for such additional work so put in.

"The piles to be of red pine timber, 10 inches square, each pile shod with a wrought iron shoe, weighing at least 18 lb.; the piles to be driven well home, and at least 2 feet into a solid material, with waling pieces, 12 inches by 10, bolted to them by wrought iron bolts, to which 3 inch planking shall be firmly spiked.

"The whole of the timber used in the bridges shall be of the best St. John's red pine or Baltic timber, and the deals from Dantzig, of such lengths as may be required, free from heart shakes, sap, dead knots, dry rot, or any other defects whatsoever, and thoroughly seasoned, having been felled at least two years, and six months out of water. All the trenails used in the bridges shall be of sound English oak. It must be stacked as soon as brought on the ground, and preserved from wet until used. All the timber must be painted with three coats of good oil paint, at such times as the engineer may direct. In measuring timber, no allowance to be made for mortices, tenons, &c., but only the net measurement taken; and the workmanship throughout to be good, sound, and firm, and such as shall be approved of by the engineer.

"All castings shall be moulded of a true form, and free from air holes or other defects, and shall be of correct measured dimensions when ready to be fitted in place. All cast iron shall be of the best No. 2 iron, re-melted in the furnace, and shall be of a quality approved by the engineer; no hot blast iron will be allowed.

"Girders shall be subject to be proved by the hydraulic press, under the inspection of the engineer, and at the expense of the contractor, according to what the substance and form are calculated to bear, and each girder shall be tested by at least one half the calculated breaking weight. Or the iron shall be of such strength, that an inch square bar, of 36 inches in length, between supports, shall bear a weight of 500 lb. suspended in the centre. And, should any castings be injured by testing, or prove unequal to the test, others, that shall be satisfactory to the engineer, shall be provided by the contractor.

"All joints shall be made to fit perfectly close and tight, and no cement stopping or plugging shall be introduced; and in all cases where iron rests upon stone, a milled pad must intervene, and the whole must be put together in the best and most workmanlike manner.

"Wrought iron must be of the best scrap, or No. 3 bar iron, approved of by the engineer, and of sufficient strength to bear, without injury, 15 tons per square inch of sectional area.

"No wrought iron straps, bolts, or other work, must on any account be hammered when cold, without being afterwards annealed. The bolts to be made so as to fit the holes correctly, after they are seasoned to receive them. All iron work must be painted with three coats of good oil paint, without being allowed to rust.

Engineer's Manual of Mineralogy and Geology. By Mrs. Varley. London: Weale. 1846.

This is a very clever little work, well written, lucid in its descriptions, and we think fully carries out the intention of its talented authoress. Mineralogy is a subject of growing interest, both as a pure science, and in its applications to the arts; and a work, divested of technicalities, and the intricacies of nomenclature, is a desideratum. No science has undergone more revolutions in this respect, as we find many minerals have no less than four or five names in different books. A knowledge of the laws, and the relations of crystalline forms, which obtain in the mineral kingdom is valuable, not only as a subject of philosophic speculation, but also in its applications to geology, chemistry, and especially to engineering pursuits. Few men have more frequent opportunities of studying practically the sciences of geology and mineralogy than engineers; for at the present time, when railways are being carried on, and the surface of the earth penetrated in almost every direction, the different strata, and the mineralogical character of the country must be constantly under their notice, and in the words of our authoress, "They ought in such operations to compare and combine an accurate observation of whatever comes under their cognizance with facts already established; and every new incident however trifling it may at first appear, if recorded with precision, will become valuable as an addition to the geological knowledge we already possess."

As an illustration of the necessity of paying due attention to the internal structure of the materials used in machinery, and more particularly to those parts which are subject to a long continuous vibration, we may instance the alterationof structure to which the iron axles of railway carriages are liable from the perpetual vibrations to which they are exposed. The toughest and most fibrous wrought iron is always selected for the construction of these axles, and from this continuous vibration the particles assume a new crystalline arrangement, assimilating to the construction of cast iron, and eventually becoming brittle. We understand this important point is under careful examination. Some very interesting specimens of iron axles which have undergone the molecular changes in question, may be seen at the Museum of Economic Geology.

We will now give a brief sketch of the subjects in the work, and the manner in which they are handled. The first 42 pages give a short account of the rocks of Devon and Cornwall; the unstratified rocks, granite, syenite, greenstone, basalt, porphyry; all of which belong to the trap formation with the exception of granite; also the places at which they most abundantly occur: then follow the stratified rocks, gneiss, mica-slate, clay-slate, the old and new red sandstone formations, carboniferous and oolitic systems, cretaceous and tertiary systems, with the minerals which are found in them—with a short account of the analysis of them, by that invaluable little instrument, the blow-pipe. Although we agree with the authoress that "in the greater number of cases, if a specimen of ore be characteristic, an accurate observation of its external character will enable us to recognise it without having recourse to chemical process;" yet we would strongly recommend students who wish to acquire a knowledge of mineralogical science, first to obtain some acquaintance with chemical analysis. A few tests or re-agents, combined with the application of the blow pipe, will enable them to perform a qualitative analysis of an ore, and thereby obtain a much more intimate knowledge of the composition and nature of the ore than could possibly be acquired by the simple observance of its external characters: again, according to Mitscherlich's law of isomorphism, there are minerals whose crystalline forms are identical, but whose chemical composition is different.

The different ores of gold, silver, copper, iron, &c. are next brought under consideration, their characters are succinctly given, and the richest ores for smelting stated. The tables of analysis of silver and copper ores are valuable, as showing the amount of metal which can be extracted from each one: we should have liked to have seen the same carried out for some of the other metals. The next part of the work treats of the mineral rocks and earths, and closes with the physical characters of minerals, embracing a brief account of the doctrines of crystallography. We would notice the only error which we have observed while perusing the work, and that for the purpose of having it corrected in a subsequent edition. It is stated, page 46, that gold is soluble in hydrochloric acid, which is a mixture of nitric and muriatic acids; now, hydrochloric acid is the new name for muriatic acid, and as such, gold is insoluble in it. Gold is not dissolved in any of the pure acids; its best solvents are chlorine and nitro-hydrochloric acid, and the latter only when it gives rise to the formation of chlorine. We might observe that fluorine also combines directly with gold. In every other respect the work merits our most cordial approbation, and our thanks are due to the lady who has produced a book which we feel assured will be useful.

The NEWLEAFE DISCOURSES *on Fine Art Architecture. An attempt to talk rationally on the subject.* By ROBERT KERR, Architect. Weale, 12mo. pp. 208. [No date.]

The author of this book ought to be condemned to write his own review of it: his principles are so indefinite, and are expressed in such diffuse language that no one but himself could give a fair analysis of them.

Trusting to the table of contents more than to an examination of the book itself, we may state that the subjects considered are mainly these:— The definition of architecture, considered as a fine art, comes first. Then follows a contrast between an orthodox, well-fed, alderman-architect, distinguished principally by a sedulous regard for the main chance, and a heterodox, visionary, artist-architect, distinguished (as we should say) by having, as times go, no chance at all. Next, the several pursuits of two such architects are distinguished, and are illustrated, moreover, by some stories which are meant to be very funny, and are in fact very puerile. Archæology, the history of architecture, Ecclesiolog*ism*, architectural study, &c., are subsequently considered. The concluding topic is the Royal Institute of British Architects.

We quite agree with the opinion published by Candidus last month (*ante* p. 328), that the book is clever and entertaining, and the doctrine (what little there is of it) excellent. We think also that the writer has displayed a generous courage in defence of his art by boldly—and without respect of persons—denouncing all attempts to degrade it. But what we chiefly object to in these Discourses is, that they are overladen with verbiage. The reader plods on—and on—and on—page after page, expecting every moment to arrive at the gist of the argument, but never reaching it till he be fairly tired out. You are perpetually reminded of eating *omelette soufflé;* or quote mentally Polonius's question to Hamlet, with the reply—

> "What do you read, my lord?"
> "Words, words, words."

The question of Precedent, which occupies our author a good deal, seems capable of being so easily stated, as to be scarcely worth discussing. Antiquity affords a presumptive, but not a final, proof of excellence. There are precedents for error as well as for truth, for bad architecture as well as for good; but still we may presume that, on the whole, good architecture would be the most carefully preserved. The noblest monuments of ancient art are old because they are good—not good because they are old. That is to say, their long preservation is the effect, not the cause, of their excellence.

Both good and bad precedents have their value, however: the former teach us what to emulate (not imitate), the latter what to avoid. It is well enough to say that all art must be ultimately criticised by the principles of beauty observed in nature; but this canon, invaluable as it is as a fundamental truth, is of that abstract nature, that its full value can be learned only from its examples. Two architects may both agree as to its accuracy and importance, and differ *toto cœlo* as to the methods of *applying* it. The right-thinking student, therefore, will not refuse to benefit himself by the efforts of his predecessors, which enable him to compare actual examples of these different methods.

Or, to view the subject a little more metaphysically, is it not clear that the principles of beauty observed in nature, are *applied* in nature in a manner in which they cannot be applied in art? What the architect wants to avail himself of are, not so much natural forms as natural principles. Now the process of separating the one from the other is too difficult to be effected by a single trial—it must be tentative. It is only after many trials and many failures that we shall be able to combine masses of masonry into forms useful for artificial purposes, and yet strictly restrained by "the modesty of nature." That a man may have sufficient genius to do this at once is possible, though not probable; but for men of ordinarily constituted minds the bare knowledge of principles is insufficient; expertness in the correct use of them is the result of actual practice. An accurate knowledge of hydrostatics, for example, does not necessarily lead to dexterity in the art of swimming; and a man may be thoroughly versed in the theoretic rules of horsemanship, and yet break his neck in the first attempt to apply them.

The attack upon the Archæologists and Camdenists is ingenious enough, but not sufficiently discriminating. Archæologists no doubt have their follies like other people, and are especially apt to consider that the most estimable parts of antiquity are its dust and rust. Still the Archæologists are our fellow labourers, and useful in their way. They have often preserved or discovered monuments of the Beautiful which had else been lost —and the Beautiful is ever to be venerated whatever be its date or the designation of its guardians. The Camdenists are a still more valuable body, for they openly avow the doctrine of progression. It is true that they are slightly touched on the subject of symbols, and are apt to wander and talk wildly when the topic is introduced. They display also a most lady-like punctiliousness on the subject of dress. But take them from their idiosyncracies and they show an honest generous enthusiasm for artistic architecture—talk like men who observe diligently, and yet are capable of reasoning for themselves; reason for themselves, and yet are not above confirming their judgment by observation.

The strictures upon the Institute of British Architects are, we fear, too correct. It were difficult to say what the Institute has done, since its foundation to advance the art which it professes. It is clear that the collection of editions of Vitruvius and prize essays on slates does not forward architecture a single step. Can the most zealous member of the Institute inform us of any one fact or opinion elucidated during the last sessions which will tend to the advancement of architecture? We know of none—except it be the ingenious investigation by Mr. Penrose,* tending to show that the Greeks observed in their works one of the sources of beauty which has been overlooked by the moderns. There were discussions *usque ad nauseam* about plaster imitations of stone, and the Five Orders, and prizes for architectural designs in which the canons of constructive fidelity were systematically violated. But efforts such as these are not progressive, but retrograde.

The truth is that the Institute is too orthodox—too big-wigged—too *donnish*, to use a Cambridge word. The individual members have, we believe, a sincere love of architecture, and are actuated by the best intentions; but they are infirm of purpose, fear to speak unless they can quote chapter and verse for their authority, and shut their eyes to the fact that the whole system of architecture has grown debased by the lapse of time, and wants reforming.

Mr. Kerr's talents are certainly above mediocrity, and his denunciations are courageous, if not the most prudent. At all events he shall not have cause to complain that we are opponents of his efforts to purify architecture. We are among the malcontents ourselves. The reform of abuses which Pugin advocated in the Pointed style *must* in spite of opposition be extended to all styles, and if Mr. Kerr will but write a little less diffusely, and lay down more definite and tangible principles, he may become an invaluable labourer in the good cause.

We had nearly forgotten to state that a considerable part of these Discourses is a republication of letters addressed to *The Builder*. This fact, in courtesy to our contemporary, ought to have been stated in the present volume. The pervading fault seems to be an over-anxiety to be facetious. We do not mean to say that there is no real original wit in the book, but simply that we have been too dull to perceive it.

A Manual of Gothic Architecture. By F. PALEY, M.A., with nearly seventy illustrations. London: Van Voorst, 1846. 12mo. pp. 304.

An instructor should always know more than he teaches. It might appear at first sight that the writer of an elementary treatise need possess no more than elementary knowledge; yet it is a matter of experience that those who have not advanced beyond first principles cannot teach first principles correctly. Profound erudition has never been more worthily displayed than in smoothing the paths which lead to the gate of knowledge.

Architecture is at present in a state of transition from a crude code of dogmas to a systematic science. Some of the simplest principles are at this moment the subjects of warm controversy, and until those principles have been definitely agreed upon, it is evidently impossible to write a complete elementary treatise upon architecture. Such a work may fitly teach all that has been strictly ascertained, but the debated points must be reserved for those who are competent for the discussion.

It follows from these considerations that there are two qualifications requisite in a Manual of Gothic Architecture—profound knowledge on the part of the author, and the exclusion of uncertain speculations. The first of these requisites is perfectly, the second generally, satisfied in the work before us. The object professed is simply to teach the uninitiated to distinguish and classify architectural details, but many of those who deem their knowledge sufficient to qualify them for the practice of the art would find their errors tacitly demonstrated in this unpretending treatise. Mr. Paley however considers the present imperfect state of church architecture neither acrimoniously nor ungenerously: he sets out by acknowledging

* See ante, p. 97.

that "we are all too ready to disparage unjustly the works of modern architects, who more frequently want the means than the power to produce Gothic works equal to those of antiquity. It is next to impossible to judge of modern designs with strict impartiality; and critics are seldom fully aware, or disposed to admit, how much their judgment is warped and biassed by that utterly false and unjust notion, that every mediæval work is good, and every modern imitative design is a failure."

The first chapter traces in general terms the history of church architecture from the fall of the Roman empire to the present time. Respecting the word *Gothic* it is observed that "the term is in itself absurd and calumnious; but it has now become so general that it avails little to endeavour to supersede it by another." We cannot assent to this conclusion. The word *Pointed* is now popularly understood to refer to all styles in which the arch is angular at its vertex, and has been so generally adopted by architectural writers that the revival of the word *Gothic* seems like a retrograde step. Moreover, Mr. Paley does not adhere consistently to his own argument, for he proposes to disturb the present terminology of English Pointed architecture and to substitute new appellations for those which at present are used without inconvenience, and being descriptive are easily remembered. The term "Third Pointed" would confound the Perpendicular of England with an altogether different style—the Flamboyant of France: a similar objection applies to the term "First Pointed." On the other hand the term "Early British," or "Anglo Saxon,"—the first on Mr. Paley's list—refers to our own architecture exclusively. His nomenclature seems therefore unsystematic; in one case his desire of generalizing leads him to overlook national peculiarities of style; in another he disregards his own generalization.

The second chapter treats principally of round-arch architecture. In the following extract, the first statement is contrary to known mechanical principles, and appears sufficiently refuted by what follows it.

"The pressure of Norman vaulting is straight downwards on the walls, that of Pointed vaulting oblique, or lateral (See Hope, p. 312). Yet, from bad construction, or other causes, Norman vaults have a great tendency to push outwards the supporting walls. The aisle of St. Sepulchre's, Cambridge, actually fell down from this cause just before its late restoration. Thus some resistance has been proved by the result to be wanting, though the want might not be known or suspected at the time."

In the third chapter the successive development of the three Pointed styles is admirably treated, and the engraved illustration possesses singular beauty.

A subsequent chapter is devoted to "the uniformity and progressive character of the Gothic styles." The following extract is a long one, but the subject is so interesting, that we have made but few omissions.

"No architect of the present day is fettered by any other rules or conditions than those imposed by his employers, in regard to the choice of a style. He may copy that of any nation and any period, and he may alter, combine, detract from, or add to it, as he pleases. Indeed he must do so more or less, because no one recognised and distinctive national architecture, either ecclesiastical or secular, exists at the present day. It is all copied, and none of it is, properly speaking, original or self-developed. It has ceased to be inventive, at least in any favourable sense.

"But the case was very different in the Middle Ages, when freemasonry was a craft in the hands of a corporate ecclesiastical confraternity, the members of which seem to have been bound down to certain rules, and yet to have had almost unlimited license in carrying those rules into effect; precisely in the same way as if the alphabet of a language were given to any one, and he were allowed to combine the letters into words as he pleased, but not to introduce any new forms or symbols. This seems exactly to illustrate the position in which the ancient freemasons stood. They had certain *kinds* of mouldings, foliage, window tracery, &c, which were, with comparatively trifling modifications and exceptions, repeated in all buildings of the same era, only very arbitrarily combined, arranged, or applied. For example, in the age of the Complete Gothic or Flowing-Decorated, all window tracery was designed on one fixed principle; it was neither geometric, nor rigidly vertical, as in the next style; but it was, with surprisingly few exceptions, of wavy and curved lines. Yet each architect seems to have had full liberty to adapt this principle to his own taste; and thus we find thousands of different patterns. Again in mouldings; some ten or a dozen forms being employed by all with inflexible exactitude, their *grouping*, or positions in relation to each other, as well as their application, seems to have been the result of individual caprice (See Hope's Essay, p. 213). And herein is the glory of the Gothic styles, that they attained by these means *perfect uniformity combined with almost infinite variety.* There is no monotony, no wearisome repetition; every detail has some freshness; yet all are strictly subjected to certain laws of composition. Hence that charm of never-ceasing interest created by perpetual novelty; for this in reality is a much more enduring gratification than either the magnificent effect or the exceeding aggregate beauty of some buildings, both which impressions are rather those of first sight, while the minute detail of any one building might engage the attention for months, or even years.

"Little or nothing has ever transpired of the secret system which the freemasons adopted in building, nor of the organisation of their body, except that it was ecclesiastical, and under the jurisdiction and benediction of the Pope. It is certain that they were a very numerous, energetic, and talented class, whose genius was chastened and ennobled by all the enthusiasm of a grand religion, and whose efforts were aided by the supply of almost unlimited resources. They must have had the entire monopoly of both domestic and ecclesiastical architecture; though perhaps the distinction is vain, for everything in the Middle Ages was ecclesiastical. ....Constant communication must have been kept up between all the members of this numerous and widely-extended body. For if we consider the immense number of churches built in every reign from the Conquest to the overthrow of the ancient religion, and the perfect uniformity of style in all of the same period, we shall perceive how complete the intercourse must of necessity have been. Perhaps the following is a plausible scheme of their constitution. Those whom we now call architects seem to have been designated 'Masters,' as we read that 'the Master' did so and so, in ancient accounts, where it is clearly equivalent to 'the Architect.' These 'Masters' must have been trained in one and the same school, just as our clergy are trained in the universities, and they seem either to have been sent about to different stations, or to have been attached to some mother church or cathedral, or even to have taken up their permanent residence in certain localities, since we often find several churches in a particular neighbourhood which clearly exhibit the same hand in their design.

"Though we may in most of the arts attribute a good deal to mere fashion, which might formerly (it may be said) admit of as little variety in architecture as it now does in the shapes and materials of costume, still this is quite insufficient to account for the positive *identity* of coëval capitals, bases, foliage, windows, &c., in the two opposite extremities of the kingdom. We suppose therefore there was either some central school whence all such details emanated, or, which is the same thing, the Masters went about as so many missionaries, disseminating what they had learnt or developed together. How this adherence to rule for a long period can be reconciled with the phenomena of sudden changes in, and eventually complete revolutions of, style, or who had the boldness to suggest, or the authority to enforce, novelties in the masonic art, must be matters of mere conjecture. In England, indeed, the employment of foreign artists will account for many new introductions; but the question remains the same,—whence did these foreign artists themselves derive them? However such changes were first introduced, they were quickly adopted *semper, ubique, et ab omnibus*.

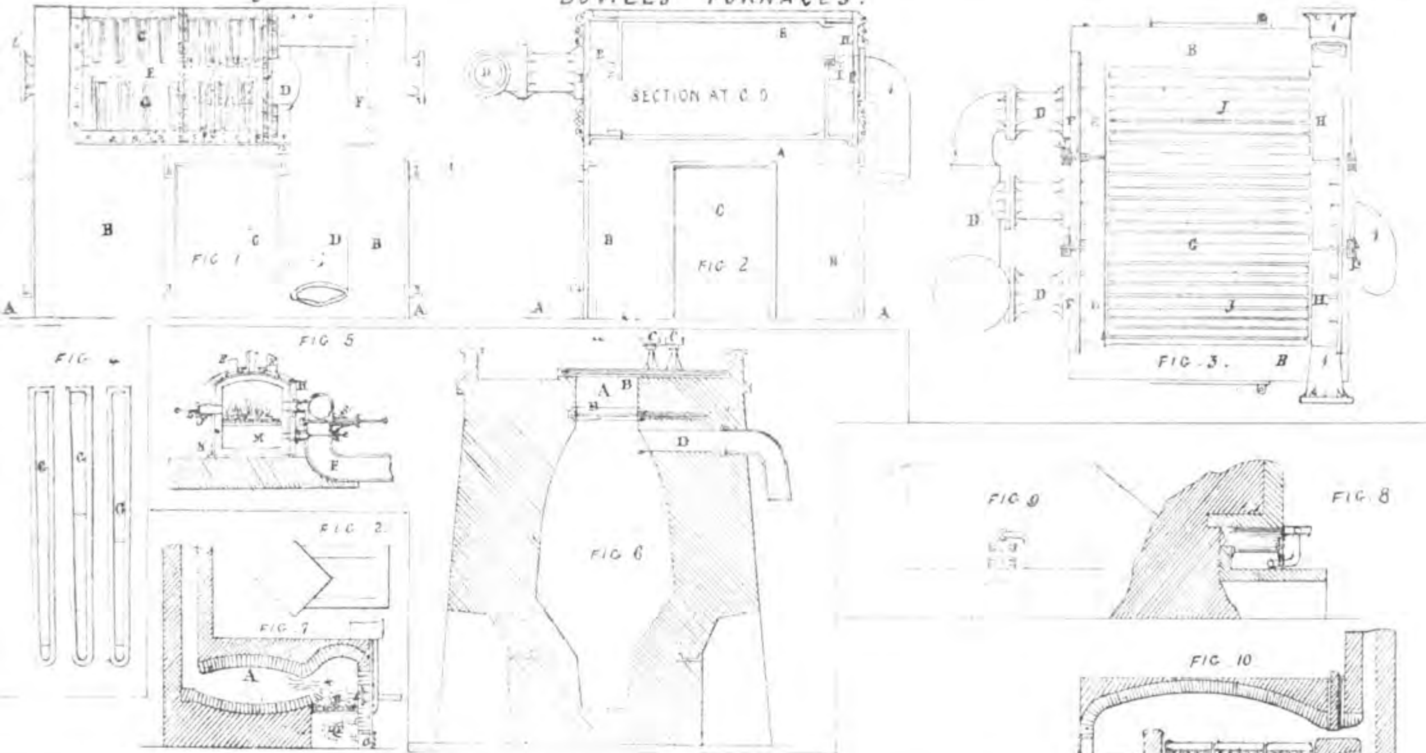
"William of Sens is the first known master mason whose works are extant. The masons were not *incorporated* in England till the thirteenth century; yet there is at least as much uniformity of detail observable in the Norman and (as before observed) even in the Saxon styles. An oath of secrecy is said to have been tendered to all novitiates.[1] They appear to have been convened and held secret meetings at certain times and places. The name *Free-masons* is a corruption of *Frères maçons*, or fraternity.[2] A presumptive proof how exclusively the details of the art were in their keeping may be derived from the blundering attempts at drawing them, which are always found in MSS., stained glass, brasses, and fresco paintings. The master masons were generally foreigners, incorporated by royal authority. When a large building was contemplated, the masons removed in great numbers to the spot; hence they have been well described as a kind of 'nomade race.'[3] How they were paid, or how maintained during their sojourn, is not certainly known. Perhaps the masters did not so much design, as carry out the designs of powerful and munificent ecclesiastics.[4] A good deal, too, of actual handy-work was done by the ecclesiastics[5] themselves, which will account for any of those touches of the satirical in the way of droll portraits, which seem so pointedly directed against rival clerics.[6] But when we read of repairs and buildings executed by abbats, bishops, or monks, we must generally understand the expression to mean that they promoted them, but that masons were employed in carrying them out.[7]

"'The old builders possessed nothing but the sound intelligence of sensible men, and an aptness in practice exercised from earliest youth. They lived more at the building place than at home; thought of little else and did little else; and thus they evidently succeeded much better than our well-grounded sages, who often bring into the world their left-handed productions, or tamely written pamphlets, and would fain superintend the erection of buildings from their writing-desk.'"[8]

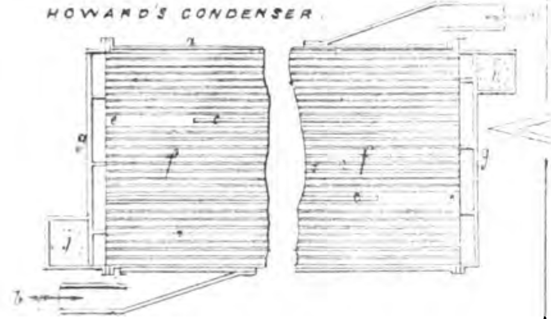
"One thing is quite clear, and admitted by all; that the masons of the time being were absolutely restricted to *one style*. They never thought of going backwards, under any circumstances whatever, and seem to have contemned the very idea of copying older work, however incongruous

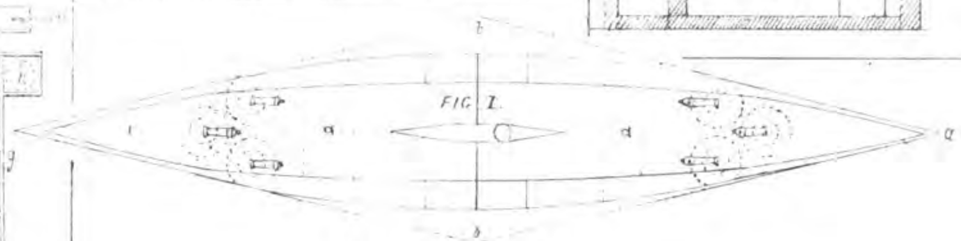
1 See Dallaway's Historical Account of Master and Freemasons. Also Hope's Essay, pp. 203—220.
2 Dallaway, p. 434.
3 Blunts History of the Reformation, p. 83.
4 Dallaway, p. 156.
5 Maitland's Dark Ages, p. 58.
6 There are good specimens in the beautiful middle Pointed chancel at Southrepps, Norfolk.
7 Willis's Canterbury, p. 120.
8 Whewell's Notes, &c., . 3 62.

BOVILL'S FURNACES.

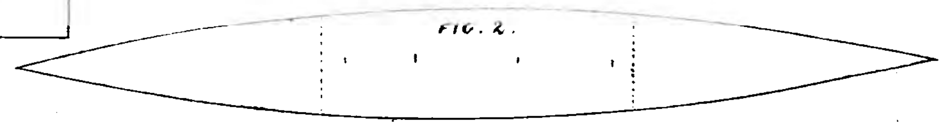


HOWARD'S CONDENSER.

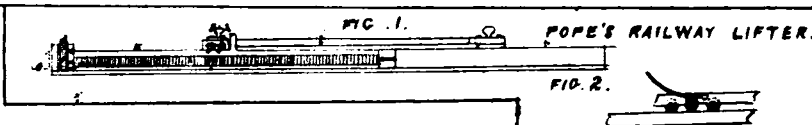


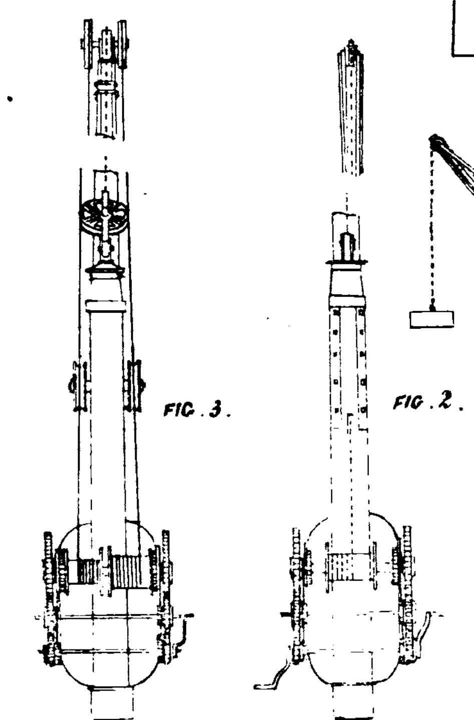


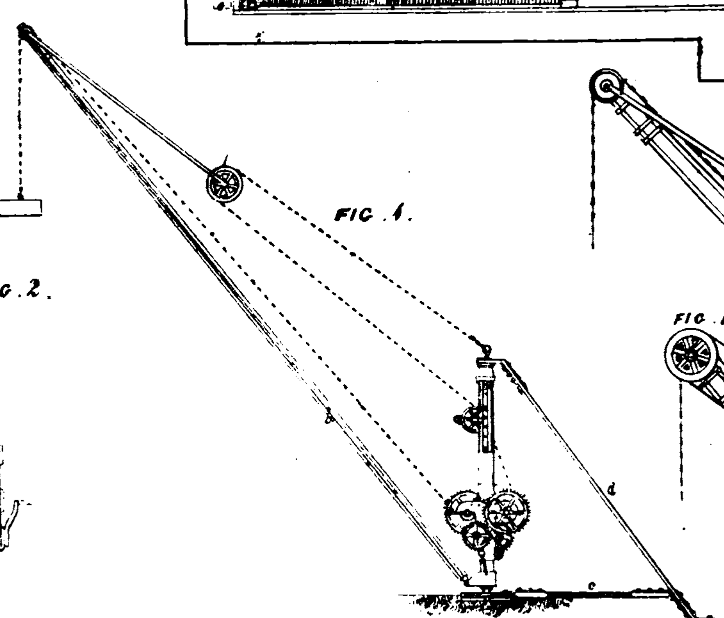
GUN STEAMERS.

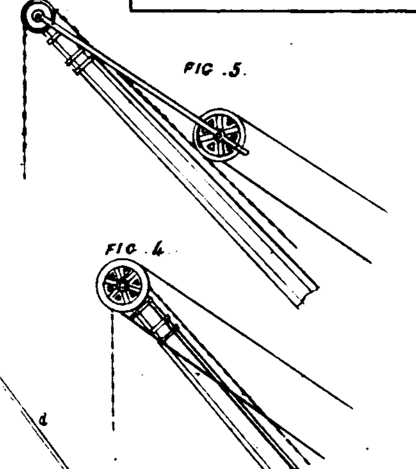


POPE'S RAILWAY LIFTER.









JIB CRANES.

would be the result of the new, in additions to, or alterations of, a pre-existing edifice. In fact, they thought they could improve upon it. Of this principle many of the most interesting illustrations might very easily be adduced, did space allow their insertion. Scarcely ever did they compose a single detail even with a view of *suiting* the older work; for in truth they had a thorough contempt for uniformity. They placed traceried windows of many lights in juxta-position with single lancets, pointed with semicircular arches, and complex Gothic columns with plain and heavy Romanesque piers........It is very possible that the masons themselves, in always using the style of their day, desired to stamp an imperishable evidence of date upon the works they were executing........In altering churches, the parts most generally preserved were doorways, nave piers and arches, north-west aisle windows (for some unexplained reason), sedilia, piscinæ, fonts. The parts most commonly innovated were windows, aisle walls, clerestories, roofs, porches, chantry chapels.

"It is very singular to observe how even the slightest changes and turnings of style were regularly adopted in the progress of such large buildings as required a great number of years for their completion. For example, the west elevation of York Cathedral exhibits early Middle Pointed work in its lower part, while the belfry windows, battlements, and pinnacles are finished of pure Third Pointed detail.* These changes we may attribute to the succession of new master masons, each of whom could or would design only in the details of his day.

"Every master mason must have been able at all times to command the services of workmen well acquainted with and accustomed to the working. Perhaps these operatives (*confrères*) accompanied him from place to place; certainly they must generally have devoted their lives to the work; for the exquisite chiselling of the boss, and floriated capital, or the statuary and canopy work of such a place as the Lady Chapel at Ely, could never have been attained without intense and zealous application, aided by great taste and artistic feeling, and long practice. Probably the few modern architects to whose lot it has fallen to carry out work of this description, would verify this from their own experience. It is one thing to design, another to find workmen capable of executing accurately the more minute and difficult details. That such workmen did anciently exist, and in great numbers too, is proved by the works they have left behind them as monuments of their skill. It is probable that they worked by drawings, as at present; or the plans were laid out for them by the master's hand, as occasion required; of which perhaps the diagrams and geometric marks sometimes found on the stones of disjointed buildings may be taken as examples. Yet there are parts occasionally to be met with which must be called 'botches,' and which are clearly the results of extemporary constructive ingenuity without any pre-arranged plan..........There must have been, for centuries previous to the change of religion, a constant, untiring, incessant zeal for church building, a zeal which is more striking, when contrasted with the dead apathy, or at least the almost exclusive plundering and demolishing, which from first to last has characterised the new system. Only let the reader contemplate the vast quantity of ancient ecclesiastical work we still have left, taking into account the *enormous* destruction of the sixteenth and seventeenth centuries, and the unceasing havoc of the combined causes of neglect, avarice, and profanation, which have been in active operation for three hundred years! When we think of some towns having anciently had forty or fifty great churches, where not more than ten or a dozen now appear, all the rest having long ago been razed to their very foundations; of a thousand abbeys and religious houses, of which scarcely one hundred shattered ruins now remain, though some of them were fully as large and splendid as our first-rate Cathedrals, —Glastonbury, Reading, Bury St. Edmund's; when we know fully what we have lost, in comparison with what we have left,—we shall be indeed amazed at the almost superhuman efforts of the mediæval church! It has been computed that each one of these vast Cathedrals or conventual edifices would cost, in our times and with our much greater facilities, from five to eight hundred thousand pounds. A million of money must have been expended on the fabric of some of our greatest churches; and if we may credit the accounts of the vast wealth stolen by Henry VIII. from Canterbury and Lincoln Cathedrals, and include all the vestments, plate, and other furnitures, the stained glass, pictures, tombs, silver statues, and shrines, we are justified in doubling that sum. How inadequate a notion do our present bare, dilapidated, and rifled structures afford, of the amount which religion once bestowed on the Church, and which irreligion has sacrilegiously taken from her!"

There are many other parts of the work from which we should like to make extracts, but our limits prevent us from extending them. We must therefore refer the reader to the work itself: we cannot however omit the following quotation in which the ancient and modern principles of church building are happily contrasted.

"Let us now observe how completely every one of these principles has been INVERTED in modern practice, and we shall have obtained some clue in tracing the causes of modern failures.

"Modern principles are:

"1. To make buildings uniform by equal and similar wings, corresponding doorways, windows of the same size and kind, level and regular elevations, not broken up into parts of greater or less prominence and height. Every Gothic new building in Cambridge exhibits these faults, which are the certain result of the same hand composing in two contradictory styles, Classic and Gothic.

"2. To add unnecessary and unmeaning ornament in conspicuous positions to attract the eye and produce a showy appearance, leaving the less exposed parts bare and naked in the contrast.

"3. To place effect before utility, as by building an inconvenient or unnecessary feature because it is supposed to look well. Hence we have doors which afford no entrance, turrets with no available interior, and chimneys which do not emit smoke.

"4. To erect buildings whose primary idea is that of a large unbroken area, without columns and arches, with wide roofs, and without distinct component parts. Such *were* the great majority of the modern churches, which often had neither buttress, nor string-course, nor arch in the whole design; in short, nothing Gothic about them except the minor details.

"5. To use *usque ad nauseam* a few hackneyed Gothic details, copied from celebrated churches or cathedrals, or borrowed from books; and to apply these without sufficient regard to difference in the *kinds* and character of buildings.

"6. To sacrifice solidity and strength to unnecessary and adventitious ornament, and to impoverish the fabric to obtain the greatest possible amount of conspicuous but needless decoration.

"7. To arrange exterior elevations without regard to the nature of the interior, or to force the latter to suit the former; as to give the outward appearance of nave and aisles where there are no columns or arches inside; of three gabled roofs where there is but one flat ceiling within; of pinnacles or gable-crosses which are but chimneys. Hence the custom of building *masks* either to hide necessary parts which do exist, or to give the idea of those which do not.

"8. To be satisfied with actual weakness without even apparent lightness, as by the use of plaistered timber to imitate stone, and by the omission of essential constructive details, such as shafts, mouldings, and the visible resistances of lateral thrusts.

"All might be summed up in a very few words. The ancient churchmen built for God, not for man; for the church, not for private interest; for religion, not for fame; for endurance, not by contract; for devotion, not in a spirit of economy; *pro salute animæ, non pro crumena.*"

There are of course many opinions incidentally expressed by our author, which might be disputed—such as the indiscriminate intolerance of Classic architecture, &c., but it is not necessary to discuss here topics which have been fully treated in other parts of this Journal. The student who desires to learn the elements of Christian architecture accurately, may be confidently referred to this work. Our criticism however relates exclusively to the architectural information: respecting the religious dogmas which the author briefly propounds, or rather alludes to, it is not within our province to offer an opinion, beyond an expression of regret that Mr. Paley has suffered his name to be involved in the religious dissensions which unhappily exist in our Universities. These disputes are in any case deplorable, but the evil of them is greatly increased when they tend to diminish the public esteem of our academic institutions as "seminaries of sound learning and religious education."

STEAM NAVIGATION.—GUN STEAMERS.

(With Engravings, Plate XIX.)

We are indebted for the following judicious remarks on a better adaptation of the light classes of steamers to the objects of the naval service, to a letter from Mr. REDFIELD to the Navy Commissioners of the United States, published in the *Franklin Journal*. It is a sequel to the report given in this Journal in September last, p. 207.

1st. The proportion of length to breadth in these steamers should never be less than the average of class C—the length being equal to *nine breadths* or *diameters*; and, if extended to nine and a half, or even ten diameters, this will perhaps be within the limits of maximum advantage. These ratios of length are especially required for objects yet to be noticed. The proportion of *depth*, however, may be slightly increased, if sufficient care be taken to restrict the top weight.

2nd. The extreme horizontal outline of the deck and guards should be brought *within* an angle of fourteen degrees from the midship line at the bow and stern; in order not only to ease of motion, but to favour the deflection of the shot of an enemy from the hull when engaged *head or stern on*. The bow and stern angles at the water line will necessarily be much finer—say within the semi-angle of eight or ten degrees. The stem and stern post should be nearly vertical, and the floor frames, or at least their rudimentary forms, should be extended forward and aft to the joinings of the stem and stern post; dispensing altogether with the common "dead wood" of the stern. Suitable provision should also be made for steering in opposite directions, with either stem or stern foremost.

3rd. The deck frame should consist of plank-sawed and deep-moulded scantlings, one to each frame of the vessel, and screw-bolted to the same in crossing to the guard or fender line. The common deck knees should

* Exeter Cathedral was, however, carried out on a uniform plan for fifty years by Bishop Quivil.

be dispensed with, and snug knees of hackmatack be applied externally, at proper intervals, where the projection of the guards will permit.

4th. There should be a very light hurricane-deck over the central portions of the hull, and extending to a length equal to two or three diameters of the vessel. All the constructions above deck should be of the very lightest description, and be comprised, if possible, within the same limit. Thus the forward and after ends, each to the extent of about three diameters of the vessel, would be left free of incumbrances; excepting the gun-fixtures and other indispensable attachments.

5th. The engine should be so placed below deck as to act directly upon the cranks, as in the steam frigate Missouri, if the midship body of the vessel will allow of this arrangement; otherwise, a half beam arrangement may be resorted to. The paddle-wheels should spread less on the shaft than is common in American steamers, and the paddle be extended to a point at its centre in a trapezoidal or triangular form. This form will admit of a greater immersion, and thus obtain a better resistance, than the common paddles, especially in a sea-way. The crank and chimney openings in the deck should be comprised in a narrow enclosure, with upright sides, extending fore-and-aft-wise to a point, so as to present an acute angle of deflection, for the protection of the crank and lower part of the chimney from shot when *end on* with an enemy. The main shafts, which must be above the deck, should also be protected by *deflecting planes*, covered with iron and slightly inclined from horizontal.

Much apprehension has been sometimes manifested for the safety of the wheels and paddles when under fire; but those who have employed steamers day after day, for successive seasons, in encountering ice from four to fourteen inches in thickness, and who have witnessed the speed of a steam vessel when one half or more of the wheel arms and paddles have been disabled in this service, will think more lightly of this hazard; to avoid which, almost every quality valuable for a war steamer has sometimes been sacrificed.

6th. To sustain the guns, the scantlings beneath them should be somewhat enlarged in thickness, and securely stanchioned and screw bolted. The gun pivots should be of strong timber, adequately secured to the deck-frame, and extending to the keelsons. The deck, where exposed to the action of the guns, should be strongly sheathed, and the whole be secured, if needful, by transverse bars, strongly bolted or clamped to the deck-frame; and, if necessary, connected by vertical bolts and stanchions with the floor-timber. When about to engage, sand bags, or other equivalent weights, may also be used for covering that portion of the deck exposed to injury from the explosion of the guns.

To illustrate my views of the proper form of construction of these vessels, I annex an approximate sketch of the deck plan and guards. This outline has, for its base, the elongated rhomb *a a*, *b b*, (fig. 1, Plate XIX.) and presents at the deck a guard line of the bow and stern, *a a*, the maximum semi-angle of fourteen degrees; which is only equal to that which has been already adopted in some well-proportioned steamers for coast service. It also contemplates a length which is equal to nine diameters of the vessel; each of these diameters being visibly set off on the plan, fig.

It will be found, practically, that this proportion of length is sufficiently limited; for the engine, if placed as proposed, will require much length, and the necessary weight must, also, for a light draft, be extensively distributed. Moreover, the first diameter at each extremity, the flotation of which can properly support little more than itself, may be viewed as substituted for the cutwater, bowsprit and other fixture, which is commonly attached to heavy steamers and sailing vessels; while the second diameter thus set off, answers practically to the usual bow and stern in other vessels; thus leaving five diameters for the proper body of the vessel and the necessary machinery and storage.

7th. The armament of each steamer, I apprehend, should consist of *six traversing guns*. Two of these, of ten inches calibre, should be worked each on a strong pivot, placed on the line of the keel, at the distance severally of about one and a half or two diameters of the vessel from the stem and stern post. The four remaining guns, each of eight inches calibre, may be worked on like pivots, placed near the sides of the vessel, and as much nearer to the main shafts as will avoid interference with the two larger guns. When engaged with an enemy, *the line of fire should always, when practicable, be in the line of the keel.* The above mentioned ordnance constitutes the armament of the recently constructed war steamers of England; and, so far as I can perceive, is the most appropriate and effective for a steam vessel: the peculiar vocation and advantages of which ought to be rapid motion and effective fire.

Perhaps some persons may entertain apprehensions of the inability of these light steam vessels to carry and sustain the action of the guns above mentioned. But these apprehensions are without any just foundations, as will appear from the following facts and considerations:—(1.) The points at which the guns are placed, require an access of weight equal to this armament, in order properly to equalise the load throughout the body of the vessel. (2.) The weight merely of these guns is no more formidable or destructive to a vessel than a like concentrated weight of other heavy articles, of which vastly greater amounts are safely carried in all weathers on lighter decks than I propose for these vessels. (3.) Owing to their large capacity, and their great superficial bearing upon the water, these vessels are better able to bear the addition of the above weight than any vessels now in the naval service.

This may appear from the following facts: First, the average load-line area, or bearing superficies, of class C is nearly *three-fifths* of that of the Brandywine frigate; while, if we allow 50,000 lb. for the guns and carriages of the steam vessel, and 48,000 lb. for the ammunition and other accessaries, it will then equal but *one-fifth* of the weight of the armament and its accessories of the Brandywine; and will require to sustain it only a draft of 4½ inches from the light load-line. Again, this average superficial bearing of the steam vessels is more than *four-ninths* that of the Ohio ship of the line: while the above weight of guns, ammunition, &c., is less than *one-eleventh* the weight of the military outfit of the Ohio. Once more, the average height of the *decks* of these steamers above the water at midships, exceeds *six feet*, with an average bearing surface of near 7¼ feet per ton of the vessel and its contents; while the height of the port-sills of the Brandywine and Ohio are but 5½ feet above water, with an average bearing superficies of nearly 2¼ feet per ton. This shows an immense proportion in favour of these steamers, in the ability to carry accessory weight. Hence, this class of steamers may not only carry this armament, but, in addition, may also transport, when occasion requires, from five to eight hundred troops.

It may be well to notice here the apparent chances of this class of steam vessels when opposed to heavy war ships of the rates above mentioned.

1. *The choice of action* and position will always belong to the steamers. This is important when opposed to any force whatever; for the most favorable time and circumstances for combat may thus be commanded, or, if it should be proper and advantageous, the action may for the time be easily avoided. While, on the other hand, an equal or inferior force need not be allowed to escape.

2. *The target surface* presented by the Ohio when in chase, below the hammock rails, is probably equal to 1450 square feet; and in broadside about 5000 square feet. The cross area of the Brandywine presented in chase is probably equal to 940 feet, and that of her broadside area near 3800 feet; while the average cross area of the hulls of the steamers of class C exposed above water, to a height of seven feet above the deck, is only 340 feet. Now, as the steamers will probably engage chiefly at long shot, and *end on*, we may here perceive how great will be the advantage for the steamers, with equal skill in gunnery, whether or not a sufficient number of steamers to match the broadsides in weight, be taken into the account.

I say nothing here of the extraneous exposure of the wheels and smoke-pipes on one hand, nor of the spars and rigging of the ships on the other: believing that these chances, with proper precautions, are not unfavourable to the steamers.

From the great stability and superior steadiness of these steamers when in motion, particularly on the line of the keel, and from the accuracy with which they may be made to bead *on or off* an object, by means of a marking point subtended above the bow, to guide the helmsman, they will afford to skilful gunners greater accuracy of fire than is usually obtained in ships, unless the latter be lying in smooth water.

In comparing the weight of metal opposed, if we reckon to the steamers the full weight which is due to the increased calibre of their guns (and considering the greater destructiveness of shells to a ship, this appears not improper), we shall find that four of these steamers, each with three guns engaged, will exceed, at each round, the weight of shot thrown by the broadside of the Brandywine; and that the fire of seven steamers will equal, in like manner, the broadside of the Ohio. While, in chase, there would be an overwhelming advantage in favour of the steamers. In these estimates the weight of shot thrown by the broadside of the Ohio is taken at 1600 lb., and that of the Brandywine at 804 lb., as by advisement; and the shot of the eight and ten inch guns at 68 lb. and 98 lb., respectively.

As regards the relative power of endurance, if shells are used, as they doubtless will be, this power in a vessel cannot be in proportion to the weight and massiveness of the structure; and may prove quite the contrary. But, if the form of model and position in action, which is here recommended, can be made efficacious in some degree for the protection of the engine and boilers below deck, which seems practicable, the steamers, with equal gunnery, must clearly have greater advantages for the endurance of fire in the aggregate than will belong to the ships. Besides, if we may estimate the aggregate power of endurance to be in proportion to the bearing area or superficial extent of the vessels, as appears not wholly improper, this advantage will be proportionally in favour of the steamers. Moreover, in shell-firing a single shot may prove fatal to a ship; while even a like result to one or more of its alert antagonists need not cause a discontinuance of the combat.

However important it may be to maintain a powerful and well ordered navy, consisting of ships of the established classes, it can hardly be in our power, or within the scope of our policy, to maintain a numerical superiority as against England, even on our own coasts. And without such superiority, or at least a near equality, effectual blockades may not hereafter be prevented; to say nothing here of the chances of losing our ships and naval arsenals, by the onset of a powerful and well appointed expedition, supported by a numerous fleet of ships and war steamers.

With the aid of her numerous and heavy armed steam ships, England might effectually blockade not only our ships, but our war steamers of the heavy and medium classes. For our steamers of these classes could hardly put to sea, or return to port, in the face of a superior force of the same character; and it would be quite in vain to attempt gaining a superiority of this force by new constructions of like kind, for the present means of England, both mechanical and financial, are sufficient to outdo us in this effort, more than three to one. It is therefore indispensable to our superiority, that we should be prepared *with faster steamers, of lighter draft*, *and equal weight of metal, with those of England.* These steamers, being of the classes which I propose, could never be blockaded in our ports by the existing naval means of any country. Moreover, if maintained in sufficient numbers, so as to be readily assembled in large squadrons at the points where the exigencies or demands of the service might require, the most powerful fleets would be unable to maintain a blockade, or to carry out with success a military expedition against our shores.

The same classes of steamers are also of essential importance on our frontier lakes, where armed steamers of the heavy classes and draft of water hitherto adopted, would be of greatly inferior value; and where all the strategetical advantages will be in favour of the classes proposed.

The greater value and adaptation of light built steam vessels, tenaciously constructed—not less in length and size, nor exceeding in weight and draft, the average of the classes C and D, may be now reviewed, or more summarily considered.*

I. Their facility of movement and surpassing speed, exceeding that of existing war steamers from three to six miles an hour, must necessarily afford, as above mentioned, the choice of action and position; and excepting accidents, no enemy can either escape or overtake them, except at the will of their commanders.

II. Owing to the light draft of water and greater speed of these vessels, they may shelter themselves from a superior force in shoal positions, or attack and annoy the enemy from such positions on a vast extent of coast and inner waters, where heavy ships or steamers cannot approach. When the elaborate survey of our coast, now in progress, shall have been completed, and our officers shall also have become familiar with these shallow grounds by active coast service, in proper steam vessels, these facilities may become of great value.

By this means, not only may the exposed positions at Key West and other points be maintained in war, and made available for the annoyance of an enemy, but the strait of Florida, if not the other outlets of the Caribbean Sea and Gulf of Mexico, may be effectually and securely blockaded by squadrons of these steamers.

By means of these active steam vessels, and a suitable and skilful force of marines and marine artillery, trained for both land and sea service, which, I trust, may shortly be provided, an enemy's colonial posts may be captured, and his military resources laid under contribution. By like means, in case of a war with England, might the coal furnishing ports, and other outposts near our eastern frontier, be taken into our possession, and retained, or abandoned, as occasion might require.

It is chiefly by these means that we may expect to command, in such emergency, the more hazardous coasts of Maine, Nova Scotia, and the Gulf of St. Lawrence; thus cutting off the communication and military supplies of an enemy, and virtually blockading his American colonies. On these rocky coasts, as elsewhere, any general degree of safety which might be supposed to result from solid built bottoms and heavy structures, may be far more than compensated by lightness of draft and tenacity of structure, and facility of movement; while in security against attack from a superior steam force, the heavy built steam vessels could maintain no equality with the light footed classes. The coast of Maine affords all necessary shelter and resources for this service; and this description of force, if matured by timely preparation, and put forth in our strength, might generally command the coasts and shores, from Quebec to Nantucket. Two or three vessels of the proposed class would doubtless prove more than a match for one of the heaviest English steam ships; and, for reasons already noted, the latter might find it difficult to escape.

By proper arrangements, and, if needful, with the associated aid of one of the steam frigates, these lighter built steamers may be sent to any part of the world, where their services may be desired, and where friendly or neutral ports can be found to afford the necessary shelter and supplies of fuel. Their great speed and efficiency might thus be employed with great effect on an enemy's commerce and resources.

I have been led, by the request of the commissioners, thus to explain, to some extent, my views on this essential branch of public defence, and to urge the adoption of a class of measures on which I consider the future safety of the country may largely depend; being fully persuaded that it is not so much on the *magnitude*, as on the *available qualities* of our naval force, that we must rely for success in any future conflict with the great mistress of the seas.

* I consider the Gladiator as being the proper type of the class D; except as being slightly deficient in length, which would be better at 200 feet.

EXPANSION OF STEAM.

Observations on the effect of using Steam expansively under different pressures, and when cut off at different points. Reported in the American *Journal of the Franklin Institute.*

I was led to the following calculations respecting steam, by a notice published some time since in the *Franklin Journal*, of the operation of the Cornish Engines. The writer of that notice intimates, that the "duty," said to be performed by the engines, is greater than the calculated power, to be derived from the fuel, and that a new theory has been proposed to account for it, by the "momentum" of the percussion of the steam upon the piston. He states that in some of the engines the steam is let into the cylinder at a pressure of 45 lb. to the inch, and "cut off" at one fourteenth of the stroke. As I could find no table showing the effect of the expansion of steam when carried so far, I prepared the following:—

Steam let on during the	Effect produced by expansion.	Total effect of the steam used.	Average effect throughout the cylinder.
Full Stroke.	0·000000	1·000000	1·000000
$\frac{1}{2}$ do.	0·693151	1·693151	·846575
$\frac{1}{3}$ do.	1·098616	2 098616	·699538
$\frac{1}{4}$ do.	1·386303	2·386303	·596575
$\frac{1}{5}$ do.	1·609448	2·609448	·521889
$\frac{1}{6}$ do.	1·791768	2·791768	·465294
$\frac{1}{7}$ do.	1·945927	2·945927	·420846
$\frac{1}{8}$ do.	2·079455	3·079455	·384932
$\frac{1}{9}$ do.	2·197233	3·197233	·355248
$\frac{1}{10}$ do.	2·302600	3·302600	·330260
$\frac{1}{11}$ do.	2·397904	3·397904	·308900
$\frac{1}{12}$ do.	2·484919	3·484919	·290401
$\frac{1}{13}$ do.	2·564958	3·564958	·274227
$\frac{1}{14}$ do.	2·639078	3·639078	·259219
$\frac{1}{15}$ do.	2·708064	3 708064	·247204
$\frac{1}{20}$ do.	2 995751	3·995751	·199787
$\frac{1}{25}$ do.	3·218896	4·218896	·168755
$\frac{1}{50}$ do.	3·912048	4·912048	·098240
$\frac{1}{100}$ do.	4·605200	5·605200	·056052

From the above table it appears that one per cent. of a cylinder full of steam, if suffered to expand, will give an average pressure throughout the cylinder equal to 5·6 per cent. of the pressure it exerted when entering the cylinder; or that the same quantity of steam, if suffered to expand to 100 times its volume, will do 5·6 times as much work as if used, without expansion, through the whole stroke of the cylinder. And when cut off at $\frac{1}{14}$ of the stroke, as in the Cornish engines, the average pressure will be more than one fourth of what it would have been, if fourteen times as much steam of the same pressure had been used. This sufficiently explains the cause of the superiority of the "duty" performed by the Cornish engines over those in which expansion is not carried to so great an extent; for it requires less water to be raised into steam to work expansively than would be required to work with steam of the same average pressure, and full cylinders. In the case of the Cornish engine the steam was used at 45 lb. pressure for $\frac{1}{14}$ of the stroke, giving an average pressure, agreeably to the table, of $·259219 \times 45$ lb. $= 11·665$ lb., and to perform the same work, with the full stroke, would have required steam of at least this average pressure. Now to determine the quantity of water required. Dalton says that steam obeys the same law as the gases with respect to pressure, and *they* have expansive force in the ratio in which they are compressed. Then steam of double pressure should contain a double quantity of water. The published tables of the specific gravities of steam give an addition of weight of only about 87 per cent. to steam of double pressure, which would contradict Dalton's position. Supposing, however, that Dalton's law is correct, and that atmospheric steam contains 253 grains of water to the cubic foot, then steam having the above pressure of 11·665 lb. would contain 435 grains; and steam of 45 lb. pressure would contain 1012 grains of water per cubic foot. But, with this last, it requires but $\frac{1}{14}$ of the quantity, or $(\frac{1012}{14} =)$ 72 grains to give the same average power, when used expansively, as the 435 grains on the full cylinder plan. The fuel required should be in proportion to the water to be evaporated. Watts's experiment with the open and closed boiler, each subjected for an equal time to an equal heat, showed that the same quantity of water had escaped, in steam, from the open boiler, as flew off from the close one, upon opening the valve at the end of the operation; thus proving that equal weights of water require equal quantities of heat to raise them into steam, irrespective of pressure. On this principle, then, the Cornish engine should require but $\frac{72}{435}$ or about $\frac{1}{6}$ of the fuel that would have been required to work them on full steam, which very nearly corresponds with the "duty" performed by the present Cornish engines compared with that done by the engines formerly constructed by Bolton and Watt in the same locality.

Another principle comes in play, in working expansively, which is lost sight of when working with equal steam throughout the stroke—viz., that matter in motion would never cease to move unless retarded by external causes, and would require, to stop it, a power equal to its weight multiplied by its velocity. Now, in working expansively, the steam is applied at a pressure sufficient to start the load at a certain velocity, to continue which, it is only necessary that the additional quantities of power should equal the retarding forces of gravity, friction, and resistance of air, until the commencement of the next stroke. Now, in the Cornish engine, where the steam is cut of at $\frac{1}{14}$ of the stroke, the increments of power beyond that point, or that portion of the power gained by expansion, amount to nearly 2·64 times the direct power of the steam applied, and which gives the original velocity. This velocity must therefore be continued until the gravity, friction, and resistance of air, amount to 2 64 times the original power, applied before cutting off the steam. The whole weight of the machinery and load thus operates, on the fly-wheel principle, to continue the motion, as the velocity given to them forms one of the factors of their momentum, which is counteracted only by the other factor, the gravity.

It is thus readily seen that the weight of the load raised by an engine working expansively, may exceed the average pressure of the steam on the piston, for it only requires the steam to be at a high initial pressure, so as to give the necessary velocity, and of course momentum, to the load at the commencement of the stroke; it may then expand so as to bring down the average pressure and leave sufficient power, to be derived from the momentum and the expansion, to carry forward the work. This reserved power will of course be applied in a decreasing progression, while the retarding powers would be constant. It will be a useful exercise of the skill of some of your mathematical friends to calculate how far the load may exceed the average pressure upon the piston.

It appears from the table that the advantage to be derived from expansion, increases with the expansion. It becomes therefore important to ascertain the extent to which it may be carried. I noticed that in the Cornish engine they use a "steam jacket" to their cylinder to prevent condensation. This led me to inquire into the heat of the steam, and how it would be affected by its expansion. Will steam expand in a cylinder from any given pressure down to that of the atmosphere? Pressure or condensation of air produces heat, and the release of it from pressure, cold. If steam be affected in the same way, and you suffer it to expand to 100 times its bulk, will not its heat be divided by 100, and be reduced below the freezing point? The cut-off steam can take up no heat from the boiler, and its inherent heat is stated to be about 1212° divided into portions, sensible and latent, according to its pressure. As each particle of steam must be supposed to contain an equal portion of heat, the heat must necessarily be divided with the expansion of the steam. Then if it contain but 1212°, and this be divided by the expansion, it is evident that before the steam can have expanded 40 times, its heat would be reduced below the freezing point, even if the latent heat all became sensible, unless it could take up heat from the cylinder, which is not of a nature to conduct it with sufficient rapidity. That the heat is divided by the expansion, any one may satisfy himself by placing his hand in the steam issuing from a high-pressure boiler. He will in the same way be convinced that steam is not frozen by expanding from 150 lb. to the pressure of the atmosphere. Now it is impossible that in this case it should take up from the atmosphere sufficient heat to prevent freezing, if the heat, originally in it, did not exceed 1212°, as indicated by our books. To account for the phenomenon, I suppose we may assume that the heat in atmospheric steam is correctly stated at 1212°, of which 212° are sensible, and 1000° latent—a second volume of water, rising in the form of steam in the boiler, takes up an additional 1212° of heat; and now the steam contains twice as much water, and twice as much heat, as atmospheric steam, shows 15 lb. pressure by the mercurial gauge, and about 242° of heat by thermometer, the remaining 2182° being latent; and so, for each individual 15 lb. of pressure, another volume of atmospheric steam would be compressed into the original space, a less portion of its heat each time becoming latent. On this theory, steam of 150 lb. pressure will contain 11 times as much water as atmospheric steam, and 13332° of heat, while the thermometer would show but about 360°. And the temperature of such steam, when expanded to the atmosphere, should be 88°. It would therefore rush into the air and immediately assume the form of water, which, judging merely from the sensation, is near the fact. The advantage of the "steam jacket," therefore, is obvious. It is also obvious, that steam of any pressure may be used, on the plan of expansion, in a condensing engine, as the heat may always be reduced, by expansion, to the point at which it may be condensed. The following calculations seem to show, that the most economical engine would be built upon this plan.

Steam at 180 lb. pressure, cut off at $\frac{1}{100}$ of the stroke, by the table, will give an average pressure of 10 lb. to the whole cylinder, and, by adding the vacuum and air pump, 10 lb. more may readily be obtained. Such an engine would therefore give a power equal to two of Bolton and Watt's, of the same size, worked with atmospheric steam. Proceeding on the data, that equal quantities of water are to be evaporated for each lb. pressure of steam, at the same expense of fuel, on both plans, we have two cylinders-full of atmospheric steam, weighing 253 grains per cubic foot on the Bolton and Watt plan, and only $\frac{1}{100}$ of one cylinder-full of steam at 180 lb., weighing 3289 grains per cubic foot, in the other. The water to be evaporated to produce the same power in both will then compare as 253 to $\frac{3289}{253}$, or, the Bolton and Watt engine will require $15\frac{1}{2}$ times as much water to be evaporated as the other, and fuel and boiler in the same proportion. The 180 lb. steam, by the theory, would contain 15626° of heat, which, divided by the expansion 100, would be reduced to 156°, while in the atmospheric steam, there would be 1212°, or nearly 8 times as much. Of course, the condenser, air-pump, and condensing water, need only be $\frac{1}{16}$ of what the two Bolton and Watt cylinders would require for the condensing process.

If Dalton be correct in the opinion that steam, like gas, has expansive power in proportion to its compression or density, we have data to calculate the maximum power of steam. Water is found to expand nearly 1800 times into steam of atmospheric pressure, or 15 lb. to the inch. Then, by compressing such steam to $\frac{1}{1800}$ of its bulk, we should get it back into water, and multiply its elastic force in the same degree, $1800 \times 15 = 27000$ lb. per square inch, the maximum.* In following the same law of elastic power in proportion to density, we find, that each expansion of steam to twice its volume, in a steam cylinder, gives precisely the same increment of power to the piston, which must move each time double the distance. Thus the distances moved by the piston for each expansion, form the series 1, 2, 4, 8, &c., and the increment of power for each distance is ·693151 of the power applied before the steam is cut off.

ERSKINE HAZARD.

Philadelphia, July 20, 1846.

* Steam thus compressed into water, would instantly give out all its heat, and produce a temperature, according to the theory, of 212° x 1800 + 1000° 382600°.

REGISTER OF NEW PATENTS.

If additional information be required respecting any patent, it may be obtained at the office of this Journal.

MANUFACTURE OF IRON.

George Hinton Bovill, of Mill-wall, Poplar, Middlesex, engineer, for "*Improvements in the manufacture of Iron.*"—Granted Jan. 31; Enrolled July 31, 1846. (*With Engravings, Plate XIX.*) Reported in the *Repertory*.

The improvements relate, 1st, to an arrangement of apparatus for heating the blast from the flames passing off from the top or funnel head of blast furnaces; 2nd, to an improved mode of heating the air or blast, by blowing the same partly through and partly over a fire in a closed retort or fire-proof chamber; 3rd, to the working of blast furnaces by exhaustion or suction, in contra-distinction to the present method of blowing air into them at a greater pressure than the atmosphere: 4th, to the introduction of steam above the boshes of blast furnaces; 5th, to an improved method of puddling iron by the application of the water furnace, commonly known as Kymer and Leighton's furnace, the same being worked by air blown into a closed ash pit, and the introduction of air over the fire to consume the gases generated; 6th, to a preparation to assist the working of iron in the puddling furnace, and its further application to facilitate the combination of steel with iron; 7th, to a mode of calcining iron ore by combining the use of furnaces with heaps of ore; 8th, to a mode of constructing furnaces for heating or re-heating iron.

Plate XIX., fig. 1 is a side elevation, fig. 2 a section, and fig. 3 a plan of apparatus placed at the top of a blast furnace, the cold air from the blast main passing through the same, and being heated by the gaseous flame passing off from the furnace top, is blown in at the tuyeres of the furnace in the ordinary manner. *a* is the top or stage of a blast furnace; *b* the brick tunnel head of the furnace, showing the doorway *c*, through which the furnace is charged, and to which doors are hung, confining the gaseous flame to pass through the heating cells; *d* the cold air main and branches from the blowing engine connected to the three chambers *e*, provided with doors or bonnets *f*, secured by bolts and nuts, air tight: the object of these doors is to get access to the socket joints, by which the connection is made with *g*, flat cells or chambers (shown in enlarged section, fig. 4), extending across the tunnel head *b*, and connected, as above-mentioned, to the cold air chambers *e* on one side, and to *h*, three similar chambers, on the other side, from which the heated air is conveyed by the three pipes *i*, to their respective tuyeres and blown in at the bottom of the furnace. *j*, spaces between the air-cells, *g*, through which all the gaseous flames from the furnace ascend, the cold air being divided into thin currents, absorbs heat in its passage through the cells *g*, from the flame of the furnace, and obtains sufficient temperature to be blown into the furnace. By this arrangement the air, being divided into thin currents, is brought into contact with greater heating surface, and consequently absorbs the heat therefrom more rapidly than when pipes of considerable diameter are employed: it is important to keep the heating cells for each tuyere distinct, and by the arrangement here shown, it is clear either of the sections may be repaired without any interference or stoppage of the others; the arrows indicate the direction of the currents. The great object of this part of the invention is to use apparatus at the tunnel head of a blast furnace of such a description, that the heated compartments through which the air passes shall offer considerable depth as compared with the width, and so that the air may be said to be in a series of very thin sheets or currents of considerable depth.

Fig. 5 is a section of an improved hot air stove for heating the air used for the blast. *h* a tight iron case, lined with fire-brick, and provided with a Kymer and Leighton's patent water grate, *i*, supplied with fuel by means of a hopper, *j*, provided with a horizontal sliding door at the end near the furnace, and at the opposite end with a piston door, *l*, that will move freely along the hopper; *m* ash pit, closed by the door *n*, and supplied with air from the blowing engine; *o* air pipe, furnished with a valve to regulate the quantity of air to be admited from the cold air main *p*, to which also is applied the nozzles *q*, to admit the cold air into the space above the fire on the water grate, where it mixes with the products of combustion and vapour of water, supplied from the water troughs of the fire-bars, and passes away through the pipes *r*, to the tuyeres of the furnace; the admission of air and consequent regulation of heat of the blast are governed by the slide valve *s*. The mode of applying the blast possesses a great advantage in giving a command over the working of the furnace: when the cinder from the furnace has a glassy appearance, indicating the presence of unreduced oxide of iron, the admission of air over the fire should be reduced or the quantity through the fire increased; on the other hand, should the furnace be working sluggishly, the quantity of air over the fire should be increased; by the application of the Kymer and Leighton's water grate, the fire bars of the furnace are preserved.

Fig. 6 represents a blast furnace, with a double hopper, *a*, the slides of which, *b*, are worked by gear from the handles *c*, on the top of the furnace; the furnace is charged by the furnace man opening the top slide and filling the hopper, which, when closed, and the lower one being opened, the charge descends into the furnace. *d*, suction pipe from furnace connected to the exhausting engine, by which is worked the furnace, instead of blowing or forcing air into furnaces at a greater pressure than the atmosphere, by which means is obtained a more perfect distribution and circulation of air through the red hot mass of materials in the body of the furnace with a smaller exertion of power; the unconsumed gases drawn off from the furnace may be profitably applied to various purposes connected with the manufacture of iron; either hot or cold blast may be used with this as well as the system at present adopted; if the former, the air may be heated by the plan already described, or otherwise. It is well known iron is frequently much injured by the presence of sulphur in the materials in the blast furnace (of which the fuel contains the largest portion), at the point of fusion this enters into combination with the iron. The object therefore for that purpose, is to apply an injection of steam and distribute it through the mass of materials in the furnace, above the point where any fusion takes place, at the upper part or above the boshes of the furnace.

Fig. 7 represents a puddling furnace, with one of Kymer and Leighton's patent water grates (fig. 2 is one of the water troughs and a bar, in large section); *a* hearth of furnace; *b* patent water furnace; *c* double fire door; *d* air pipe through which the air is blown from a blowing machine between the plates of the fire door, and distributed over the furnace combining with the gases of the furnace, more particularly produced from the decomposition of the water, and producing an intensely hot flame; *e* ash pit, with closed door *g*, and air valve *f*, for regulating the supply of air from the blast pipe through the fire. In commencing the operation of puddling, it is preferred to introduce a portion of some carbonaceous substance mixed with the iron.

The sixth part of the improvements has for its object the preparation of what the patentee calls a cinder, to be used in the puddling furnace, when puddling iron and also when piling iron, or iron and steel, in order to facilitate and improve the welding of these matters. In preparing this cinder, take Cumberland ore, or oxide of iron, such as hammer scale from the iron forge, and charge the same into a cupola or other blast furnace, with the slack of anthracite coal or other suitable fuel, and cause the same to be melted by the blast, and tap the furnace from time to time, and allow the melted cinder to run out and become cold, or it may be used by being conveyed at once to the puddling furnace. In charging the furnace, the Cumberland ore or other rich oxide of iron is first mixed with a like quantity of the slack or culm of anthracite coal, and the charge is continued as it descends into the furnace. The cinder for puddling is to be broken into small lumps; and when the iron has been brought to the metallic state in the puddling furnace, is to be stirred in about 20 per cent. by weight of the cinder to the iron in the furnace, and then the balling process is to be completed as usual. In using the cinder when piling iron, or iron and steel, the cinder is reduced to powder, and dusted over and amongst the surfaces to be welded, by which the process will be facilitated and improved.

The seventh part of the invention consists of a mode of calcining iron ore, by combining the use of furnaces with heaps of ore, in place of combining the ore and fuel in heaps and igniting the whole mass. Fig. 8 shows a section of a furnace and a heap of ore; and fig. 9 a front view thereof. The furnace is so arranged that a blast of air may be applied below the fire bars as well as over the ignited fuel above, the ashpit being closed. The flame and products of combustion are thus forced through the heap of ore, and the same becomes calcined by the passage of the products from the furnace.

The eighth part of the invention relates to a mode of constructing furnaces for heating or re-heating iron, and the improvements consist of so forming a reverberatory furnace, that, in place of the flame and heat passing off at the end of the furnace, it is caused to descend through the bed of the furnace, which is made open for that purpose. Fig. 10 represents a section of the furnace. The general construction is similar to an ordinary reverberatory furnace, and is provided with a passage at the end into the chimney, for the purpose, when first lighting the fire, to get up the heat to allow the working to take place in the same way as if it were an ordinary reverberatory furnace; but on the slide being closed, the bottom of the furnace is so openly formed, that the heat and flame pass through the bed into the chimney. The bottom of the furnace is preferred to be constructed of a series of brick arches, *a*, leaving a space of about two inches between the neighbouring arches, or, instead of the brick arches, a water grate may be used as the hearth; and to facilitate the draft of the chimney, a steam jet is applied at *b*, or other convenient means may be used. In working with this furnace, the bottom is covered with coal or coke of such size, that it will not pass through, and on such bed is placed the iron to be heated. By such construction of furnace it will be found that the reheating of iron will be facilitated and the cost reduced.

STEAM ENGINE CONDENSERS.

Thomas Howard, of King and Queen Iron Works, Rotherhithe, Surrey, engineer, for "*Improvements in steam engine condensers.*"—Granted March 25; Enrolled September 25, 1846. (*With Engravings, Plate XIX.*)

This invention applies to such condensing steam-engines as have their boilers supplied with water of condensation, and wherein the steam is condensed by injecting water properly cooled down. A tank *a*, is placed in any convenient situation, and supplied with cold water by pumps or otherwise at *b*, and which having its course governed by plates *c*, *c*, within the tank, escapes at *d*, as further shown by the arrows. The ends of the tank are closed by plates which are recommended to be of brass, *e*, *e*, pierced with holes, in which are secured, water tight, the ends of tubes of copper or other appropriate metal, *f*, *f*, *f*, a section of one row in height only being shown in the drawing, but which extend through the breadth of the tank. Bonnets *g*, *g*, are fixed over the plates and open ends of the tubes, (and so as to be removeable if access be required to the tubes,) and are divided into compartments, which in either bonnet alternate in position with those in the opposite one at the other end of the tubes, as shown in the drawing. A nozzle, *h*, on one bonnet is connected by a pipe or otherwise with the hot cistern, and a nozzle *i*, on the other is connected with the injection cock of the steam-engine. Within the nozzle *h*, is a plate *h'*, perforated with small holes. A quantity of water being introduced into the hot cistern (by first starting the engine with the ordinary injection, which it is recommended to be attached or otherwise) sufficient to fill the tubes, and properly effect the circulation, the injection cock connected with the nozzle, at *i*, is opened, when the warm water in the hot cistern will pass by the atmospheric pressure through the opposite nozzle at *h*, and to and fro along each series of tubes determined by the divisions in each bonnet (and as shown by small arrows), and will be reduced to nearly the same temperature as the external water, supplied at *b*, and will, after passing through the nozzle *i*, and effecting the condensation by its injection, be withdrawn by the air-pump of the engine in the ordinary way into the hot cistern, from whence it will again circulate, through the tubes, being cooled and reinjected continually, as before described. Any waste which takes place is made good by the ordinary injection, which the inventor prefers to the use of stills; but the latter may be employed upon any ordinary plan if required. He does not confine himself to the precise arrangements hereinbefore described.

The injection water and the external refrigerating water may be made to change positions, the former to pass without and the latter within the tubes. The cold water may be supplied by any known means. It is recommended that the refrigerating surface be about ten square feet per nominal horse power, when the steam is so employed as to leave the cylinder of the engines at 10 lb. per square inch pressure, irrespective of the atmosphere, and be more or less accordingly, and that the supply of external or cold water be not less than twice the quantity of the injection water.

The inventor states that patents were granted to him, dated 13th October 1825, and 30th November, 1832, in both of which was included a process of condensation by the reinjection of the same water or other liquid, which he does not hereby claim.

But he claims the so arranging apparatus, that the water for condensation shall be subdivided into many streams in its progress to be cooled and used as injection water, as herein described.

RAILWAY LIFTING APPARATUS.

Thomas Pope, of Kidbroke, Kent, gentleman, for "*Improvements in apparatus for moving railway carriages on to railways, and in machinery for lifting and moving heavy bodies.*"—Granted March 25; Enrolled September 25, 1846. With Engravings, Plate XIX.

The invention relates firstly, to an apparatus for moving railway carriages on to or from a line of railway in case of accidents or otherwise; and, secondly, to apparatus for lifting and moving heavy bodies. Fig. 1, Plate XIX. shows a side view of the apparatus for moving railway carriages; *a* is a frame with a screw shaft *b*, turning in bearings at each end; on one end of the shaft is fixed a pinion *c*, which takes into another pinion *d*, with a winch handle *e*, and on the shaft is a female screw with a travelling nut *f*, with a pin that passes through the groove or opening in the top of the frame *a*, and secured in a hole to the plate *g*; the two plates *g*, *g'*, carry portions of two rails *h h*, and the plates are connected together by the rod *i* and rest on friction rollers *j*, which run on the frame *a*. When the apparatus is to be used, the carriage, supposing it to be off the rails, is raised at one end by a screw-jack or lever, then the apparatus is placed under the carriage with the rails *h h* under the wheels, and if the carriage be not far off the rails, one end of the frame *a* is placed on the line, and then by turning the handle, the end of the carriage is gradually brought over the line or part of the way, then it is either lowered on the rails or allowed to rest, and the apparatus applied to the other end of the carriage and shifted, and so on shifting the apparatus from end to end until the carriage is correctly over the line, or in place of one apparatus two may be used to shift both ends at once.

The rod *i* is made moveable so as to adopt the apparatus to different gauges of railway, and instead of the pinions on the shaft *b*, the shaft may be made to revolve by a screw wheel taking into a screw wheel *b*. The inventor does not confine himself to the apparatus, he says in some cases a simple ratchet-wheel may be placed on one of the rollers taking into a rack on the frame *a*, as shown in fig. 2. The frame *a* may be dispensed with, and any planks of wood used to form a bed for the plates *i* to run upon.

The second improvement is for an apparatus for lifting purposes, consisting of a case with a screw inside, and a female screw working up or down with a bracket thereon, and passing through the side of the case. On the top of the screw shaft is fixed a toothed wheel which takes in and is driven by a worm wheel turned by a handle.

STAINING AND ETCHING GLASS.

Isaac Hawker Bedford, of Birmingham, for "*Improvements in the manufacture of window and other glass.*"—Granted June 12; Enrolled September 12, 1846.—(Partly invented and partly communicated from abroad.)

The improvements relate to staining and etching glass. The staining is effected by the use of copper to produce a red colour either before or after cutting and polishing the glass, and the whole or any part of the surface may be stained; the invention is most successfully performed with glass made without the use of soda. The glass is to be well cleaned, and treated in the following manner:—take one part by weight of sulphuret of copper; two parts of the scales of iron from a smith's forge; three parts of sulphate of copper burned to whiteness; and four parts of calcined yellow ochre, all ground as fine as possible with the essence of turpentine, which has become rather thick by exposure to the atmosphere. The mixture being of the consistency of cream is laid on the surface of the glass to be stained by a brush, and allowed to dry; the glass is then placed in a stainer's muffle and heated to as high a degree of heat as it will allow without melting. The fire is then drawn off, and the glass allowed to cool down slowly, and washed when cold, when the appearance of the glass should, on looking in a direction edgewise of the glass, offer a greenish yellow if lead has been used in the making of the glass; the colour obtained will, however, differ according to the composition of the glass. The glass is again placed in a muffle, and heated as before; when the fire is withdrawn a quantity of small coal is introduced into the lower part of the muffle; (4 lb. of coal is the quantity for a muffle 24 inches in diameter and 30 inches in length). The muffle is then completely closed and luted, by which the products of the coal will be prevented escaping. The muffle and the glass are to be allowed to cool down, and when the glass is taken out, it will generally be found to offer a brownish-red colour. Those articles which offer such colour are then to be placed in another muffle which has been lime-washed, and again heated and cooled down as before.

The second part of the invention relates to ornamenting of glass by a peculiar process of etching. For ornamenting window glass take five parts of puce-coloured oxide of lead (peroxide) to one part of flux, (the flux employed is 17 parts of glass of borax and 13 parts of red lead fused together); the oxide of lead and the flux is ground with turpentine, and with this composition the artist paints the desired devices or designs on the surface of glass to be etched: when coloured glass is to be etched, acetate of lead is preferred in place of the oxide of lead; the same are then allowed to dry, and the articles are to be fired in the same manner as when gilding on glass, and allowed to cool; and when cold they are dipped in a weak solution of nitric acid in water, and the surfaces cleansed by rubbing off the preparation above mentioned.—The claim is firstly, for the manufacturing stained window or other glass, by applying copper for producing a red colour for staining the same on the surfaces, as herein explained; and, secondly, for the mode of manufacturing window and other glass, by etching on the surfaces thereof by means of lead acted on by acid.

STEAM ENGINES.

Mark Rollinson, of Brierly Hill, near Dudley, engineer, for "*Improvements in steam engines.*"—Granted May 7; Enrolled November 7, 1846.

The improvements relate to obtaining additional power by admitting steam in the upper part of the air pump of steam engines during the down stroke, simultaneously with the admission of steam in the steam cylinder. The air pump has a solid packed piston, and valves and passages communicating with the condenser.

COKING ARTIFICIAL FUEL.

Ferdinand Charles Warlich, of Deptford, Kent, gentleman, for "*Improvements in the manufacture of fuel.*"—Granted April 7; Enrolled Oct. 7, 1846.

The improvements relate to the subjecting of moulded fuel to the process of coking; for this purpose the patentee prefers the manufactured fuel, consisting of the small of anthracite coal, of free burning coal, and of bituminous coal, mixed with pitch or bituminous matter moulded into bricks; to be heated in retorts or ovens to drive off the volatile products (as described in a patent granted October 5, 1843, to the present patentee). The bricks are then placed one upon another with a small space between the sides, in a coke oven, (a square one is preferred), when they are converted into coke by the ordinary process.

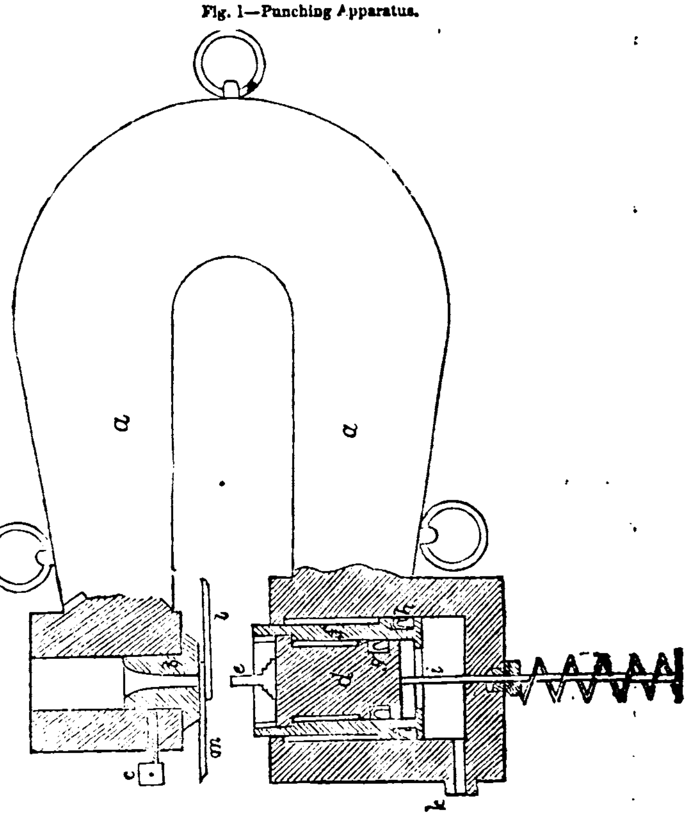
PUNCHING AND SHEARING.

Charles May, of Ipswich, Suffolk, civil engineer, for "*Improvements in machinery for punching, rivetting, and shearing metal plates.*"—Granted April 15; Enrolled October 15, 1846. (Reported in the *Patent Journal.*)

This invention consists of the application of different modifications of the principle of the hydrostatic press.

It consists first in its application to the punching of metals, used for boat building, boiler making, &c. Fig. 1 represents a side view of this improved machine, which is partly exhibited in section. It is a strong iron frame *a*, in the shape of a horse shoe, the upper arm of which is furnished with a die *b*, the size of the hole in which corresponds with the size of the hole desired to be perforated in the plate or plates of metal; it is affixed to the arm by means of a pinching screw *c*, which admits of its being changed for a new one, or one of a different size. The extremity of the lower arm is cast hollow and fitted with a ram or cylinder *d*, similar to the ram of a hydraulic press; this ram *d*, carries the punch *e*, used to force out the hole in the metal plates. It is placed directly opposite the hole in the die *b*, into which it is received when forced upwards. Another external or annular cylinder *f*, which is bored to suit the external diameter of the ram *d*, and the exterior is turned to fit the hollow in the arm; both these cylinders have cap-leathers *g h*, placed in recesses turned to receive them, which prevent the water escaping between the surfaces of the cylinders when the pressure is applied. Attached to the centre cylinder is a rod *i*, which passes through a stuffing box in the bottom, and has attached to the other end a spiral spring, which withdraws the punch from the plates after the hole is punched. *k* is the aperture to which the tube is attached to form the connection between the pumps and the press.

Fig. 1—Punching Apparatus.



The frame *a* may be of any other convenient form, but the patentee prefers the foregoing, as it may be easily suspended by the rings from a traversing crane, and moved about in any direction where it may be required; the pumps being placed on the platform of the crane, and connected by means of a flexible tube, the best for which purpose being of metal, and coiled round in the shape of a spiral, having a sufficient number of turns to give it the requisite flexibility.

The action of this apparatus is as follows:—The plates *l*, *m*, having been introduced between the punch and die, water is forced in below the rams by means of pumps, one of which should be considerably larger than the other, in order to take up the slack, and the small one to produce the pressure. The water being thus forced in, will raise both cylinders *d* and *f*, until they meet with some resistance from the plates; the external cylinder *f* forcing them close together, and the pressure being continued, the internal cylinder or ram will rise still further, and force the punch *e* through the plates; and on the water being allowed to escape, the cylinders will be withdrawn by the action of the spiral spring, both of which cylinders are furnished with suitable collars, so as to prevent either of them being forced or depressed beyond a proper range.

The second part of this invention relates to the rivetting together plates of metal by the same means as before described for punching; the only difference in the machine being, that rivet sets are adjusted in the same position as the punch and die; to receive and form the rivet heads, it is not necessary that it should be furnished with a double ram or cylinder.

The third part relates to the shearing and cutting of metal plates, the machines for which, are modifications of that already described, one being exactly similar to the common form of Bramah's press, but furnished with a double ram. The patentee proposes to use this for cutting such articles as railway axle guards. A punch, of the shape of the article desired to be cut, is fixed on the head of the ram, and a corresponding die in the cross head; the ram, on being forced up by the means already explained, will cut the metal plate the shape required.

Fig. 2—Cutting Shears.

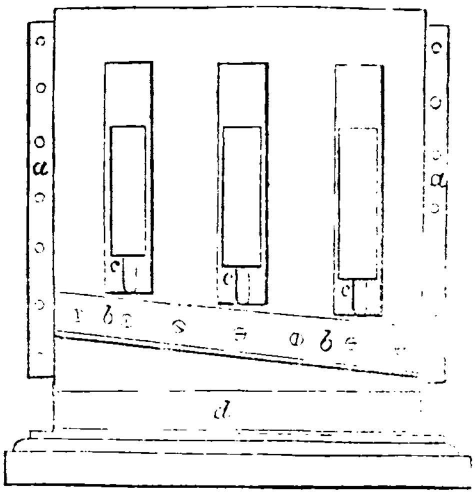


Fig. 2, represents a front elevation of a machine of shearing; *a*, *a*, is a strong iron frame, supported in a vertical position by means of dovetail guides, in which it moves freely up and down; *b*, *b*, is a knife or shear, attached to the frame *a*; *c*, *c*, *c*, are a series of hydraulic rams, by which pressure is applied directly on the knife or cutting shear; the corresponding shear *d*, is stationary, and a fixture to the frame of the machine.

Having described the manner of applying the invention to the different purposes for which it is intended, the patentee wishes it to be understood, that he lays no claim to the details as herein described and carried out, nor to the application of water for the same purposes; but claims, first, the application of the pressure of a fluid, caused by means of pumps, for the punching of metals. Second, the application of the pressure of a fluid, caused by means of a pump or pumps, for the rivetting together plates of metal, as hereinbefore described. Third, the arrangement of a series of hydraulic rams, for the purposes of shearing metal plates, as hereinbefore described.

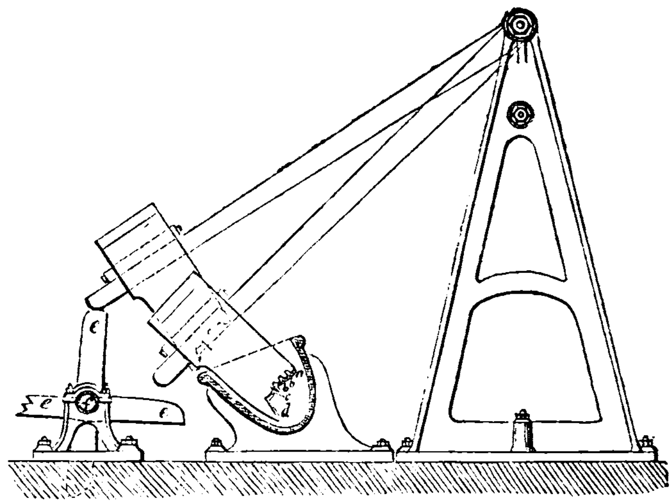
APPARATUS FOR PREPARING FIBROUS MATERIALS.

William Newton, of Chancery Lane, Middlesex, civil engineer, for "*Improved modifications and novel application of known machinery and process to the purpose of cleaning, softening, dividing and preparing flax, hemp, and other vegetable fibrous materials.*" (Being a communication.)—Granted August 14, 1845; Enrolled February 14, 1846.

The invention relates to the employment of an apparatus similar to the ordinary fulling-stock, for beating, breaking, or operating upon textile plants of all descriptions, and for constructing the beaters and trough or bed of the stocks in the manner hereinafter described.

Fig. 1 is a vertical section, and fig. 2 a plan of the apparatus; the bed or trough may be made of cast iron, copper, or other suitable metal, the internal surface is formed of three curves; the first curve is the front of a radius of 10 feet and 2 feet in length, which is the length of the arms of the beaters; the bottom curve is 10 inches in length and 10 inches radius, and the back curve 19 inches in length and 24 inches radius; the trough is about 24 inches wide on the top. The wooden beaters are of equal size, and lifted by rotary tappets *e*, falling alternately on the substances in the trough, they are about 400 lb. in weight, and have a fall of 2 feet, (the weights and fall may be varied according to the degree of hardness and resistance of the plant). The beaters have 5 teeth, the front tooth is 2½ in. thick, and projects half an inch beyond the two following or intermediate teeth *b b*, which are 2 inches thick, forming an arc of an inch radius, and the fourth tooth *c* is 1¼ inch thick, and 2½ inches longer than the first, and the fifth and last tooth *d* is 4½ inches thick, and projects nearly 7 inches; a space of 2½ inches is left between the 4th and 5th tooth. The upper surface of the beater is perpendicular to the first tooth, and curved to the shape of the trough. The teeth are covered with sheet copper, and the arms of the beaters are mounted so as to vibrate in an arc concentric with the front curve of the trough.

Fig. 1.



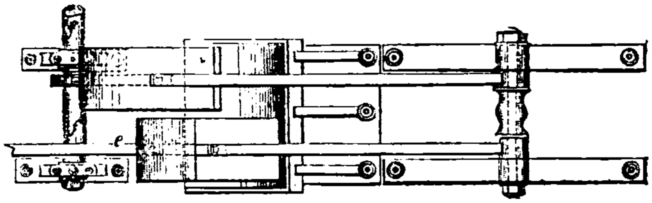


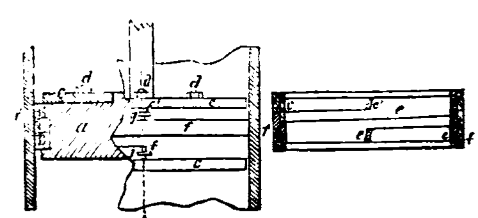
Fig. 2.

The operation is performed in the following manner:—the plants are firmly twisted together in bundles of about a pound each, and then cleansed and deprived of all gummy and other extraneous matters, and softened by being beaten or pressed. About 80 lb. of the plant is then laid on the trough and submitted to the action of the two beaters, acting alternately for about four hours.

This alternate action of the beaters turns the plant over and over, in a regular and uniform manner, compressing it forcibly against the sides of the bed, and causing the fibres to rub against each other at every stroke of the beaters. The outer covering or woody portion of the plant is first broken and then removed by the peculiar shape of the teeth of the beaters. After a time the outer covering and ligneous matter being broken off, the filaments are separated and the plant gently heated, which facilitates the removal of the gummy matters, and all the parts become softened. After this operation, and a cleansing in water, the fibres are operated upon in the ordinary matter.

METALLIC PISTONS.

William Mather and Colin Mather, of Salford, near Manchester, millwrights and engineers, for "*Improvements in metallic pistons.*"—Granted April 28; Enrolled October 21, 1846.



The improvements relate to the mode of packing pistons by a combination of two helical springs, one within the other, as shown in the annexed figure, one-half of which shows the outer spring *a*, and the other half the inner one *b*, which surround a groove or channel formed round the body of the piston *e*; they are compressed and held in their places by the top plate or cover *d* of the piston when fixed down by three screws *e*; at the two ends of the outer spring, there are filling or stopping bits *f*, placed across the two openings in recesses formed in the outer spring in order to stop the steam passing down or up through the splits.

The two springs *a* and *b* are made by first forming a cylinder by casting and then cutting out a portion of the metal in an inclined direction, a vertical cut being made at the points *a'*, *a'*: when the springs are put together, the two ends of the outer spring are made to come at the opposite side of the piston to the two ends of the inner spring. The outer spring *a* is formed with an inner flange, and the inner spring *b* comes between the flanges, and causes by its elastic force, to open out and press the top and bottom surfaces of the outer spring *a*, against the top and bottom plates of the piston. As the two springs require to be compressed when the piston is introduced into the cylinder, they will when in exert an expansive force and fill up the cylinder in which it is working, notwithstanding any wear either in the cylinder or the packing.

The claim is for packing of pistons by the use of helical springs *a* in combination with spring *b*.

MARINE ELECTRIC TELEGRAPH.

Arthur Philip Perceval, of East Horsley, Surrey, Clerk, for "*Improvements in communicating between places separated by water.*"—Granted April 23; Enrolled October 23, 1846.

These improvements consist—First, when the electric wires have been effectually secured from water, by thread and gum or caoutchouc, they are to be enclosed in a "necklace of iron rings in contact with each other, or of iron sockets dove-tailing one into the other. Coil it on the deck like any other cable, and throw it overboard in transit." Secondly, where this means of communication is unavailable, transfer a semaphore apparatus on land, to hulls, fixed at proper distances and secured by anchors, sufficiently spacious for the accommodation of men to work the signals.

AMERICAN PATENTS.

Granted in August, 1845, reported in the American Franklin Journal.

For "*an Improved method of making matrices for casting printers' type.*" Thos. W. Starr, Philadelphia.

This is for forming matrices on types by the electrotype process, which afterwards are properly fitted up to give the necessary strength and durability. Claim.—"Having thus fully described my method of forming matrices for casting the face of printers' type, and other articles therein, what I claim as new, and desire to secure by letters patent, is the manner of forming the same by means of a common type or cut, and a metallic plate with an opening, with slanting sides, the two arranged and prepared in the manner described, and placed in a solution of sulphate of copper, and connected with the pole of a galvanic battery, in the same manner usually practised in electrotyping; and after receiving a sufficient deposit of copper, to be fitted up for use, in the manner set forth."

For "*an Improved method of lessening friction in clocks, &c.* Eli Terry, Plymouth, Connecticut.

The claim is for "the employment of a suspension piece, arranged and operating substantially in the manner of that which I have denominated the friction-preventor, for sustaining the weight of the balance wheel and its arbor. The arbor of the balance wheel is supported by a stirrup which vibrates as the balance rotates, so as to relieve the journals or pivots from the friction due to the weight of the balance."

For "*a composition of matter for removing acids from cloth, &c.* Solomon Guess, Boston.

This compound consists of 4 lb. of fucus vesiculosus (sea or bladder wrack) boiled in 3 pints of water until reduced to one, mixed with one quart ox gall, 1 lb. of carbonate of ammonia, ½ lb. of alum, and 24 lb. of common white soap; the whole is properly melted and mixed together.

For "*an Improvement in the propeller.*" John Ericsson, New York City, N. Y.

The claim is for constructing the hub with perforated projections, and the combination of the same with elliptic braces, for the purpose of sustaining and strengthening spiral propeller blades. The projections from the hub to which the blades are attached are made hollow for the passage of the water in the direction of the plane of the face to which the blade is attached. And the elliptic braces are segments of hoops made oblique to the axis, and therefore elliptical—they are used to brace together the blades about midway between the hub and tips.

Machine for folding sheet metal. Henry A. Roe, Erie, Pennsylvania.

The patentee says:—"The nature of my invention consists, first, in attaching what I term the folding plate, that is to say, a plate which gripes the edge of the sheet of metal, and on which the folding is effected by the folder, to a bed placed below it and hinged to the bed of the machine, so that the sheet of metal can be folded entirely over, instead of griping the sheet by a square jaw extending above and forming a stock above the plane of the bed of the machine, as heretofore, which prevents the sheet from being folded entirely over, and therefore requiring a secondary operation to complete the folds. Secondly: In supporting the said folding bed, to which the folding plate is attached, in the middle of its length by a joint bolt, the head of which lies in a semicircular recess in the folding bed and as near as practicable in a line with the axis of motion, and secured in the bed of the machine. Thirdly: In the employment of a side plate below the folding bed and back of its journals, provided with inclined planes on which projections from the back of the folding bed rest, so that by the working of the side plate by a lever at the end of the machine, the folding plate can be made to gripe and liberate the sheet of metal."

For "*an Improvement in the propeller.* Leonard Phleger, Wilmington, Delaware.

The invention consists in making the wings of the propeller in the precise form of such a portion of the convex surface of a regular cone as would be cut out by a plane or planes passing through its axis, and comprehending about half of its surface, each wing being attached, along one of its straight edges, to the shaft.

GUN COTTON.

It will be remembered that Dr. Otto, of Brunswick, claims to be considered one of the inventors of gun cotton, and states that he was led to the discovery by a remark published by Pelouze, in the *Journal de Chemie.* M. Pelouze, at the Academy, on the 2nd November, says, on the subject of gun-cotton: "Although M. Schönbein has not published the nature or mode of preparation of his cotton, it is evident that the properties which he assigns to it can only apply to xyloidine. Reasoning on the hypothesis that the *poudre-coton* is nothing else than xyloidine, I may be permitted to say a few words with respect to its history, and of some of its properties. Xyloidine was discovered in 1833 by M. Braconnet, of Nancy. He prepared it by dissolving starch and some other organic substances in nitric acid, and precipitating these solutions in water. In a note inserted in the *Comptes rendus de l'Académie des Sciences,* in 1838, I showed that the xyloidine resulted from the union of the elements of the nitric acid with those of starch, and explained, by this composition, the excessive combustibility of the substance produced. I ascertained—and this I think is a very important result in the history of the applications of xyloidine—that instead of preparing it by dissolving the cellulose, it might be obtained with infinitely greater facility and economy by simply impregnating paper, cotton, and hemp with concentrated nitric acid; and that these organic matters thus treated took fire at 180 degrees, and burnt almost without residuum, and with excessive energy: but I think it right to add, that I never for an instant had an idea of their use as a substitute for gunpowder. The merit of this application belongs entirely to M. Schönbein. Eight years ago, however, I prepared an inflammable paper by plunging into concentrated nitric acid, a sheet of paper known in commerce by the name of *papier ministré.* After leaving it there for twenty minutes, I washed it in a large quantity of water, and dried it in a gentle heat. I have recently tried this paper in a pistol, and with about three grains pierced a plank two centimetres in thickness (about three quarters of an inch), at a distance of twenty-five metres." The results of experiments at Paris, under authority, were communicated to the Academy on the 9th inst. The proved advantages of the gun-cotton appear to be, cleanliness, rapid combustion without solid residue, the absence of bad smell, lightness, no dust possible, and therefore no sifting necessary, an indisputable force, and valued at present as triple that of an equal weight of gunpowder. The disadvantages are—volume, and hence a difficulty in making up, and in the transport of ammunition; and the production of a large quantity of watery vapour within the guns, which is, perhaps, more inconvenient than the dirt of ordinary powder. Of five specimens tried, one fired the fourth time without the gun having been sponged, was projected with the greatest part of the cotton unburnt, and this was so moist that it would not take fire in the open air.

Test of quality.—M. Pelouze announced an important discovery by two of his laboratory pupils; it is, that when xyloidine has reached its greatest degree of explosive power, then it is completely soluble in ether. Hence a test of quality, and a proof of the best make.

At a meeting of the Chemical Society of London, the same day, a paper was read *On the Gun Cotton,* by Mr. E. F. Teschemacher. The author stated that he entered on this subject with a view of obtaining some data as to how far the possible introduction of this substance in the place of gunpowder was likely to affect the consumption of saltpetre and nitrate of soda. The gun cotton examined was made by Mr. Taylor's process. Fifty grains of South American cotton were dried over a water-bath, and lost 3·40 grains. It was steeped in the mixed acids, washed, dried, and found to have increased to 79 grains. The acids used were then examined, by saturating with carbonate of soda, and it was found that the cotton had taken acid equivalent to 28½ grains of soda; or 48 grains of dry nitric acid had combined with the 46·60 grains of cotton, forming the 79 grains of gun cotton. The synthetical composition was stated as

46·60 cotton, less
15·60 water taken away by the sulphuric and nitric acids, leaving

31·00 cotton deprived of a portion of its constituent water,
35·55 oxygen } equal to 48 nitric acid.
12·45 nitrogen }

79 parts, or
39·25 cotton deprived of a portion of water,
45·00 oxygen } equal to 60·75 nitric acid.
15·75 nitrogen }

100 parts.

Thus it would require 114·75 parts of saltpetre, or 99·10 parts of nitrate of soda, to form 100 parts of gun cotton. Mr. Teschemacher directed attention to the large quantity of oxygen—viz., 45 parts in every 100—which must be derived for combination with the cotton. He stated that he had also experimented upon other vegetable substances, such as flax, sawdust, &c. He found 50 grains of flax to increase in weight to 72 grains, but that the combustion of this substance was less perfect and less rapid than that of gun cotton.

The gun cotton does not ignite when violently struck. It may occasionally be made to *decrepitate*—not explode—by percussion. The King of Prussia has issued a decree extending all the safeguards for the manufacture, keeping, and selling of gunpowder to this new explosive material.

Professor Schönbein, in a letter to the *Times*, denies the identity of the xyloidine of M. Pelouze with his gun cotton, as believed by some chemists and as stated in the Academy of Sciences at Paris. The difference between them, he says, will be made known at the proper time. Until then, also, we may here remark, the several experiments and their results that have been made public can be received only as the performances and effects of certain explosive materials, concocted by sundry individuals, and not as proofs of the properties or capabilities of *the* gun cotton.

WESTMINSTER BRIDGE.

Our attention has been drawn to the following announcement in the daily journals:—

"Demolition of Westminster Bridge and Construction of a New One.—It is definitively arranged by the Westminster Bridge Commissioners, that the present bridge shall be removed. It is intended to apply next session for an act to pull down the old bridge and erect a new bridge, from the eastern end of Whitehall-place, to Sutton-street, in the York-road, Lambeth. Powers are to be taken in the act to allow the commissioners to make the following new streets in connexion with the bridge:—1st. A new street from the south side of Charing-cross by the south-west side of Northumberland-house to the north bank of the Thames, near the end of Whitehall-place, passing over Angel-court, Craigs-court, the eastern ends of Great Scotland-yard. and Whitehall-place. On the Surrey side of the bridge there will be a new street in a direct line to the east side of the Westminster-road, to Mason-street, Lambeth. On each side of the bridge it is intended to construct large and commodious piers for the use of the steamers plying on the river. The bridge will, it is said, be constructed of granite."

We fear the construction of this new bridge will be most detrimental to existing interests, and cause the greatest inconvenience to the inhabitants of Westminster. It will not only destroy the direct line of thoroughfare from Pimlico through the Park and Great George-street, over Westminster-bridge to the Elephant and Castle and the Surrey roads, but it will be the cause of increasing the traffic through the already over-crowded thoroughfares from Charing-cross to the City, as it is now far nearer and quicker to go from the Law Courts and Parliament-street over Westminster-bridge to the City, the Brighton and Dover Railways, and ultimately to the new station of the South-Western Railway; and consequently this traffic, if this new bridge be constructed, will be directed along the Strand; and besides, there will be a distance of a mile through Westminster from Vauxhall-bridge to the site of the proposed new bridge that will be entirely cut off from the Surrey side, excepting by the circuitous route over those two bridges. By a reference to the map of London, it will be seen that if this new bridge be carried over the river at right angles to the shore at Whitehall-place, the end on the Surrey side will almost come in contact with the foot of Hungerford-bridge! Surely the direct communication from Charing-cross over this last bridge is ample accommodation for the public, without intruding another within a stone's throw.

Why the new bridge should be removed from the present site of Westminster-bridge we cannot devise. A new bridge might be constructed on the eastern side of the present bridge, and the latter pulled down when the new one is erected, as was done with Old London Bridge. By removing Westminster-bridge, the only land-view from which a perspective view can be obtained of the new Houses of Parliament will be lost, and, as we before stated, all the elaborate and minute sculpture and decorations will not be seen. To get a view of the grand facade, we shall be obliged to go in one of the river steamers, and catch a transient glimpse as the vessel passes along.

Can it be supposed that Parliament will sanction such a scheme, to the destruction and despoilation of all the valuable interests connected with the trade and property in Westminster and Lambeth? and ultimately cause another bridge to be constructed, at the expense of the public, somewhere above the new Parliament Houses, which must follow if Westminster-bridge be removed from the present site.

MACHINE FOR PRINTING TWELVE THOUSAND SHEETS PER HOUR.

We have been shown the model of a printing machine, which we have little hesitation in designating a stride in the already wonderful progress that has been made in the printing art during the last five and twenty years. The steam press by which the *Daily News* is printed is, we believe, the fastest—because the newest, and, consequently, provided with the latest improvements—at present in existence; yet the average number of copies it produces within the hour is 5,000. The improved machine is calculated to print 12,000 per hour; and after a careful examination of the model, we have every reason to believe that the calculation is correct. To persons unacquainted with the details of printing machinery it will be next to impossible to convey a complete idea of the improvement, simple as is the principle on which it has been effected: a general notion may, however, be given. For the benefit of the uninitiated, we must premise that the present printing machines consist of two principal parts; first, of a sliding table, the middle of which is occupied by the type, each end having a surface on which the ink is distributed, and from which it is taken up by soft elastic rollers, and imparted to the type, secondly, of cylinders constantly revolving, to which the sheets are conveyed by tapes, impressed by the periodical sinking of the cylinders upon the type, and conveyed away again by the tapes. By the present plan, as the impressing cylinders revolve in one direction, an impression can only be taken at each forward transit of the type; the cylinders being lifted, to clear the type as it travels back again. In other words, the type passes under each cylinder *twice* to produce *one* impression. The new, or, as it is aptly termed, "The Double-action Machine," takes advantage of *both* passages of the type under its cylinder, printing a sheet as the type passes backward as well as when it goes forward. This is managed by reversing the revolutions of the cylinders at each stroke, simply by means of straight racks placed upon the long edges of the table, in which work cog-wheels attached to the axles of the cylinders. In this double action resides the main feature of improvement. It not only allows of two sheets being printed for one, but—by disencumbering the steam-press of the machinery necessary for lifting the cylinders that they may clear the table at each return—admits of the introduction of eight cylinders into the machine instead of four, the present maximum number. By this accession seven sheets are printed in the time of four—the natural supposition would be eight sheets; but a peculiarity it would be impossible to explain in this paragraph prevents the double action being imparted to the two outside cylinders, which constantly revolve as of old, in the same direction, and which reduces the ratio of production one sheet per stroke of the machine. There are many minor advantages derived from the application of the new principle, that would, if described, involve the general reader in a maze of technicalities which would not be, to him, very interesting. The inventor and patentee is Mr. William Little, publisher of the *Illustrated London News*. We are told that his first draught of the invention was so correct, that in making the model not the minutest alteration was found necessary—a proof of the soundness of the mechanical principle from which he started.—*Daily News*.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

Nov. 2.—The President, Earl De Grey, in the Chair.

Mr. G. Allen and Mr. C. Mayhew were elected Fellows, and Mr. C. Barry, jun., an Associate.

A paper was read by Mr. Mair, "*On an Ancient Structure existing at Al Hather, in Mesopotamia, and on some Antiquities recently discovered by* A. H. Layard, Esq., *at Nimroud*;"—the description and drawings having been forwarded by that gentleman. Of the building at Al Hather, which appears to have been both a palace and a temple, considerable remains still exist. They were visited by Mr. Ross, the surgeon to the British Residency at Bagdad, in the year 1837; and again by Messrs. Ainsworth, Mitford, and Layard, in 1840,—when the latter gentleman took the dimensions and made the drawings exhibited by Mr. Mair. As to the precise date of the origin of this building, there is a difference of opinion; but Mr. Layard conceives that it owes its origin to the Sassanian dynasty of Persian kings. At the time of Jovian's retreat, the city was deserted; but, as the character of the ruins in question is that of a later date, it is probable that, after the treaty of Dura, the Persians, seeing the importance of Hatra or Al Hather, rebuilt and strongly fortified it. By an inscription repeated more than once upon the walls of the palace, it appears that that building was restored in the year of the Hejira 586 (A.D. 1190). The period of its final desertion is not known. The resemblance of these ruins to those at Ctesiphon is striking. To this day, the mode of construction adopted by the Sassanian Kings of Persia has been preserved in most parts of that country:—the centre of the edifice being usually occupied by a hall of large dimensions, which extends the whole depth of the building, and is open only at one end. It is called the Aiwam; and is flanked by a number of smaller rooms, generally forming two stories. The whole structure usually stands in the midst of a large court-yard, ornamented with gardens, fountains, and reservoirs. The palace at Al Hather has three aiwams (two of which are 98 feet long by 48 feet wide); but in other respects it closely resembles, in arrangements of the apartments, the modern houses of Shuster and Dizful, in Western Persia. The arches over the entrances are richly adorned with human busts; the head-dresses of which are extremely varied and peculiar,—but generally resemble those found in Persia on monuments of the Sassanian dynasty. The stone of which the building is composed is a very fossiliferous limestone. The blocks are well cut, neatly fitted, and firmly united by a fine and tenaceous cement. On each of them is found a peculiar mark, to which some have ascribed a mysterious meaning; but Layard appears convinced of their having been used solely in connexion with building purposes—as they occur also on those stones which could not have been exposed when the building was perfect. Mr. Mair then read a letter from Mr. Layard, respecting his discoveries at Nimroud. The mode of construction is described as peculiar. Slabs of marble, highly sculptured, are placed against intervening walls of sun-baked bricks. The roof was, probably, flat, and constructed entirely of timber. Ornaments and rings of ivory, copper, and porcelain are found among the ruins. The rooms are paved with either slabs of marble, layers of bitumen, or bricks. In some parts of the building, glazed and *painted* bricks occur;—the ornaments of which are extremely elegant, and the colours very brilliant. They are still in perfect preservation. Mr. Mair exhibited to the meeting drawings of one of the *bas-reliefs* representing chariots and warriors, and of one of the winged human-*headed* lions,—which excited considerable attention and curiosity.—It was stated that Government had lent its aid in promoting these researches; and that eight *bas-reliefs* and other sculptured fragments were on their way to this country.

Nov. 16.—S. ANGELL, Esq. V.P., in the Chair.

John Haviland, Esq., of Philadelphia, was elected as honorary and corresponding member.

The following paper was read:—"*Remarks on the Art of the Marbles from Halicarnassus*," by CHARLES NEWTON, Esq., M.A. (of the British Museum); and Drawings of the Bas-Reliefs, by JOSEPH BONOMI, Esq., were exhibited to the Meeting.

Mr. NEWTON proposed to consider whether these marbles really formed part of the celebrated Mausoleum of Artemesia. He stated that the description of Halicarnassus left by Vitruvius is far more minute than that of most cities of antiquity; but unfortunately the interpretation of some expresions made use of by that author are so doubtful as to leave the question of the site of the principal buildings mentioned by him still open to much difference of opinion. Mr. Newton then explained, by reference to an enlarged copy of an Admiralty chart of that part of the coast, his arrangement of the various buildings surrounding the port—which was only a partial adoption of Vitruvius's description, and would make the spot now occupied by the fortress the site of the *palace* of Mausolus; while that of the mausoleum itself would appear to have been situated where the modern street of the town now exists. Still, there are no remains which would justify any positive conclusion on this point. Adopting, however, this arrangement, the marbles in question must then either have formed part of the palace, and have been used in the construction of the fort as materials lying "in situ,"—or, if fragments of the mausoleum, they must have been brought for that purpose from the higher ground.

Mr. Newton then proceeded to consider whether the style of these sculptured fragments is that of the period at which the celebrated mausoleum was constructed (B C. 350); and whether they are worthy of the great reputation of the artists employed in the adornment of that monument. With respect to the subject represented—a Combat between Amazons and Greek Warriors—Mr. Newton entered at some length into its connexion with the mythical history of Caria, or of the house of Mausolus. These figures appear on the coins of several cities of Caria, and other parts of Asia Minor; and the myth was, without doubt, sufficiently national to account for its being chosen as the subject for the decoration of so important a monument as the mausoleum.

Lastly, Mr. Newton referred to the structure of this monument itself,—giving interisting extracts from Pliny, from the Comte de Caylus, and from several ancient MSS. Few of the conjectural restorations of the monument estirely agree: the data—particularly the dimensions on which they have been made—being slender and equivocal; the question of the relative size and position of the substructure or basement, and the consequent arrangement of the steps, being doubtful. The description given by Pliny is too doubtful to enable us to adjust the measurement of the frieze to any of his dimensions. In default, then, of more direct evidence of the site which these marbles originally occupied, their dimensions considered architecturally, or the character of their execution and subject, we must remain contented with the positive declaration of Fontanus—that the fortress of the Knights of Rhodes was built out of the ruins of the sepulchre of Mausolus; and, on the faith of this declaration, consider that in these marbles we possess fragments of one of the seven wonders of the world.

Professor DONALDSON offered some remarks on the Design of the Mausoleum erected at Halicarnassus by Artemesia, and read some extracts from his journal, in illustration of the description given by Vitruvius of the site of the ancient city; and in describing the existing antiquities there, alluded to many fragments of the Ionic order, lying about the modern town, now called Boodroom. Mr. Donaldson exhibited his restoration of the Mausoleum, and also drawings of the details of a Doric temple and other antiquities, from measurements taken by himself on the spot.

Professor COCKERELL, R.A., stated his intention of devoting two Lectures, in January next, at the Royal Academy, to the subject of this and other similar Mausolea, and invited the attendance of such Members as felt interested in the subject.

The following resolution of the Council respecting the Halicarnassian marbles was announced:—

"That the circumstance of the opening to public view, in the British Museum, during the vacation of the Institute, the sculptured marbles recently obtained from Boodroom (the ancient Halicarnassus), demands special notice and record; and the Council therefore avail themselves of the opportunity afforded them by this, the first meeting of the session, to express the gratification they feel, that these important and interesting relics of antiquity are now secured for the general advantage of artists, and for the promotion of art, in this kingdom.—The Council reflect with satisfaction, that the acquisition of these valuable monuments of ancient art has been effected through the suggestions offered to her Majesty's Government, by the architects of this country, in the year 1841, and they desire to express the acknowledgments of the Members of the Institute for the courteous attention given to the representations then made to her Majesty's principal Secretary of State for Foreign Affairs, the Viscount Palmerston, through whose instrumentality so desirable an addition has been made to the National Collection.

The CHAIRMAN announced, that since the last meeting, an application on the part of her Majesty's government had been made to the Council, for their opinion relative to the position of the equestrian statue of the Duke of Wellington, on the arch at the entrance to the Green Park; in consequence of which, a report had been prepared and forwarded to Lord Morpeth, and the Council had reason to believe that the recommendations therein would be adopted by her Majesty's Government. The report was read as follows:—

"That the effect of the equestrian statue of the Duke of Wellington, on the top of the arch at the entrance to the Green Park, is unsatisfactory, and its position there most objectionable.

"The Council in the first place deem it proper to observe, that the following opinions are given as those of the Council only, there not being time sufficient to submit the question to a general meeting of the Institute; but a well grounded impression prevails, that few, if any dissentient voices would be found among the members to the judgment of the Council in this matter.

"The Council next refer to the strong opinion expressed by the architect who designed the arch, and who has supported his objections with much of sound and excellent reasoning; and they consider it a recognized principle amongst artists, that the architect who designs a successful work is by far the most competent authority upon a question as to the propriety, size, and character of any sculptural adjuncts or decorations proposed to be applied to his own design.

"Independently of the valuable opinion referred to, the Council feel, that the statue is by far too large for the mass it was intended to decorate, and discordant with that harmony of proportion which is indispensable between the structure and its sculptural embellishments. The size of the arch is apparently diminished by the colossal dimensions of the statue; the elegant screen of columns towards Hyde Park, and indeed all the contiguous buildings are alike affected, and the grandeur and importance of the principal approach to the metropolis is thus lessened by the false scale produced by the colossal size of the statue.

"The most celebrated statues of colossal or heroic size were all placed on suitable plinths or pedestals on the ground, and not applied as crowning ornaments to buildings. The Jupiter at Elis, the Minerva at Athens, the Marcus Aurelius in the Roman Capitol, and the Group on the Quirinal, may be cited among many other ancient statues; and of modern times, the statues in the Square and Loggia at Florence, of San Carlo Borromeo at Arona, Peter the Great at St. Petersburg, and George the Third in the Long Walk at Windsor, may be instanced.

"In conclusion, the Council feel, that if the statue were removed to an approved site, and the arch enriched with appropriate sculptural decoration, under the superintendence of its architect, such decorations being accessorial and subordinate, it would then no longer be subject to the severe criticism of artists, foreign visitors, and persons of acknowledged taste."

NOTES OF THE MONTH.

A correspondent of the *Athenæum* writes from Freiburg, that in the architecture and internal decorations of almost all the buildings lately erected, we see the most gratifying displays of taste and skill in adaptation. Some of the new railway stations exhibit extraordinary elegance in design and fertility of invention. I would particularly refer to all the buildings erected in connexion with the line of railway extending from Mannheim to Freiburg, under the direction of the architect of the Grand Duke. From the policeman's cottage to the grand central station, all have been designed with a view to utility and ornament. The smaller buildings have a good deal the style of Swiss cottages, with overhanging roofs, quaintly carved. The central stations are distinguished by a clock tower, and have something of an Elizabethan character. A great deal of ornament is expended in the roofs of the sheds over the platforms. An arched portico, the ceiling of white and red brick, covers the approach to the pay windows and post office. At each extremity of the building devoted to waiting rooms, clerks, offices, &c., rise two pavilions, or square turrets, inhabited by the superintending officers of the railway. It is easy to imagine that, with such arrangements, a very imposing façade may be produced. In its construction, white bricks with stone dressings have been employed, and a profusion of carved wood; the roofs, which are steep and visible from all sides, are composed of tiles of three colours, light brown, dark brown, and green, arranged in diagonal patterns. The internal decorations of the waiting rooms and the flower frescoes of the walls and ceiling are all designed by the architect. A good effect is produced on the platforms by red and white tiles laid in ornamental patterns.

Burnettizing Timber and Marine Insects.—Sir W. Burnett, the head of the Naval Medical Department, paid his annual official visit to Sheerness, on Saturday, 7th November last. About 18 months ago a series of small logs of ash, elm, pine, teak, "condie," or New Zealand fir, beech, and oak, after having been duly immersed in his solution, were deposited at neap tide at the mouth of the harbour, with another series of the same kinds of wood in their natural state. On being taken up and laid out for inspection on Saturday, externally Sir William's series exhibited the smoothest surface; but, on being split open, with certain exceptions like the series which had not been immersed in his solution, they exhibited one living mass of "pholades," the generic name, we believe, of the worm in question, encased, where not broken, in their testaceous coverings. The Malabar teak, in both cases, was riddled like a sieve, as were the ash, the elm, and the beech; the pine was in rather better condition; the oak was not much affected; the "condie" was as perfect as when at first laid down, with the exception of one single worm, who had found his way into one of the extremities of the log which had not been immersed in the solution. The exterior of all the kinds of wood was considerably injured by a smaller insect, particularly the pine and the teak. As has been stated, the exterior of Sir William's series was not so much decayed, but, as to the interior, there was little difference from that of the other. Some of the worms inhabiting the interior were 8 or 9 inches long, while few were shorter than 2 inches; all were about the circumference of a medium-sized quill, and each possessed a testaceous covering and cell for itself. Deriving its sustenance through the pin-head opening in the exterior of the wood, it keeps the smaller extremity constantly there, while with the other, gradually enlarging, it bores for itself with its treble-shelled proboscis a cavity in many instances sufficiently large to admit the little finger.

Another Bridge over the Thames.—Parliamentary notices have been given to apply to Parliament in the next session to bring in a bill for constructing a bridge across the river Thames, from near Essex-street, Strand, to the opposite shore, near to Dowson's-wharf, in the Marsh and Wall liberty. Also for making and maintaining a market, at the south end of the proposed bridge.

Railway Station at London Bridge.—The London and Brighton and South Coast and South Eastern Railway Companies are making preparations for the erection of a large and elegant station, to supersede the present incommodious building. It is designed to extend from Joiner-street and New-street on the west, Maze-pond and Wells-street on the south and south-west, to the London and Greenwich Railway on the North of Crucifix-lane. The streets at present passing under the station are to be blocked up.

Metropolitan Improvements.—It is reported that the following extensive improvements in the vicinity of Leicester-square are to be made. The whole of Upper St. Martin's-lane is to be demolished, and a street, 101 feet wide to be formed, to be ultimately carried through the heart of the Seven Dials to Tottenham-court-road. A new street, to be formed at the junction of St. Martin's-lane, Cranbourn-street, Newport-street, and Long-acre, in a line through to King-street, Covent Garden, and the Strand, the south end of St. Martin's-lane, near the church, will also be widened by throwing back the houses at the corner of Hemming's-row, and a communication opened between Coventry-street and Oxford-street, by throwing down the pile of buildings separating Rupert-street and Berwick-street. The cost of these undertakings will, it is stated, be 120,000*l.*

The Birkenhead Docks are now progressing very rapidly, and it is expected that one of them will be ready to be opened for business at the beginning of the new year.

St. James's Chapel, Morpeth, is built of stone, in the Norman style; the architect is Mr. Terry, of London.

Liverpool.—In consequence of the great increase of traffic on the North Western line, the company contemplate pulling down the present terminus at Lime-street, with all its appendages, and erecting another upon a scale of magnitude equal to the requirements of this leviathan establishment. To effect this object it has become requisite to remove about 450 feet of the Edge-hill tunnel, at the extremity adjoining the station, and to excavate the solid rock for a considerable distance at either side. Even the space thus cleared has proved inadequate; and it is contemplated to remove the church near Rupert-street, London-road, and on its site erect carriage-sheds, and other appropriate buildings. The church, which is a handsome edifice of recent construction, will be replaced by another to be built at the expense of the company, in the most suitable position that can be found for the purpose. The architect of the company has been requested to furnish plans and estimates for the new station, with a view to the immediate prosecution of the works upon the necessary act having obtained the sanction of parliament. It is supposed that upwards of two years must elapse before the works can be completed, and that the cost will exceed 300,000*l.* It is also proposed to construct a tunnel from Lime-street to Wapping, for the purpose of conveying goods from the docks.

It is reported that the Wellington Statue will be placed in the open space between the Horse Guards and the enclosure in St. James's-park.

The Great Britain.—The attempt to construct a breakwater to defend this vessel have totally failed, and she has recently suffered such additional injuries that the engines and masts are at length about to be taken out.

Sewers.—It is stated that there are 50 miles of sewerage in London.

Electric Telegraphs in London.—Pipes containing wires, communicating with the Southampton Railway telegraph, are in the course of being laid down in the Kennington-road. These pipes are put about 18 inches below ground, and run beside the foot pavement. They will be continued to Charing-cross and the Royal Exchange.

Brighton.—A new infirmary has been erected at Brighton, for diseases of the eye. The architect appears to have been afflicted with an opthalmic disease himself, or else to have been desirous of bringing custom to the institution. The architecture (!) follows the approved fashion of sticking the imitation of the portico of a Greek temple on to the front of a modern square-built dwelling-house.

Sherborne Abbey Church is to be restored under the superintendence of Mr. Farey, who proposes to remove the galleries, &c.

Croydon Atmospheric Railway.—A correspondent of *Heparath's Railway Journal* states that this railway will be converted into an entirely locomotive line.

South Devon Line.—It is said that the repairs of the breaches made by the sea, and the defences against future injuries, will cost £100,000.

The North British Line has again been seriously injured by the sea. An embankment at Lamberton, within a few yards of the sea, has fallen.

On the Chester and Holyhead line also great injury has been done by the sea; a great part of the sea-wall at Penmaenmawr has been washed away. Why *are* railways built close to the sea? The engineer must have somewhat of King Lear's madness, who

> "Contending with the fretful elements,
> Bids the wind blow the earth into the sea."

The Barrentin Viaduct of the Rouen and Havre Railway has been rebuilt in a substantial manner. It is 100 feet high, and 1,500 feet long, and has been completed in the short space of six months.

Glasgow Cathedral.—It is very gratifying to learn that this edifice is being restored. The Scotch possess so little good architecture that they should take care of what they have.

According to the *Edinburgh Register*, a corps of surveyors is now engaged in the trigonometrical survey on Ben Nevis in Scotland, where they have a theodolite, constructed by Ramsden, 3 feet in diameter, with 8 microscopes, reading to tenths of seconds; and by which, with the aid of sun mirrors on distant mountain tops, it is expected that observations may be taken at a distance of 120 to 150 miles.

Eton College Chapel.—The great east window is being filled with stained glass. The Marchioness of Lothian has contributed the glass for one compartment, and the boys for three other compartments.

The Cambridge Botanic Gardens.—The vice-chancellor planted the first tree on the 2nd ultimo. The *Cambridge Chronicle* says: "Twenty men are actively engaged in deeply trenching and leveling about seven acres of the ground, intended for the immediate reception of as many of the principal groups of the larger descriptions of trees as can be procured before winter. The curator, who is zealously superintending the work, has found both the depth add quality of the soil much superior to what he had anticipated: and he considers even the poorest portions, towards the south-west angle, perfectly suitable to certain tribes. The gentle undulations over the whole twenty acres, and the introduction of a large sheet of water, where the depression is greatest, will tend greatly to break whatever of formality it may be necessary to observe in the scientific grouping of the various objects that are cultivated in a botanic garden."

Covent Garden Theatre.—The whole of the interior of this theatre before the curtain, from the ceiling to the foundations is to be taken down, and the area of the pit considerably enlarged, consequently a larger number of boxes will be obtained, of which there will be five tier, the greater part of them being private. The stage will also be advanced considerably before the curtain; there will likewise be several other alterations for the convenience and comfort of the public who patronise the Italian Opera, one will be to make a carriage drive under the grand portico in Bow-street. When finished the interior will have a magnificent appearance. These extensive alterations are entrusted to the directions of Benedict Albano, Esq.

NOTES ON FOREIGN WORKS.

The Royal Foundry and Machine Manufactory of Munich.—Amongst the great works executed of late at this establishment, are the statues for the great fountain on the Freiung-square, at Vienna. The middle part of the fountain, constructed of large-grained granite, will be surrounded by five statues, 8 feet high,—the Danube, represented by a female, which, with a far-reaching look and placid countenance, seems to contemplate the expanse of that river; the Po, as the guardian of Italy, is represented with a key in her hand; the Elbe, and the Vistula. On the summit of the work appears the figure of Austria, a proud, sublime, stately figure, but unfortunately represented with the attributes of strife and contention—the spear and shield.—The four statues for the Jubilee column at Stuttgart, representing allegorically the four estates of empires—warriors, teachers, traders, and producers, have been cast from the models of Professor Wagner, at Stuttgard, whose thoughtful and delicate style is generally admired.—The Huskisson statue at Liverpool, and that of Charles John, King of Sweden, for Norkorseing, have given general satisfaction. The prepartions for the casting of another portion of the statue of "Bavaria" causes great excitement; it is the largest ever executed in ancient or modern times. The upper part is already cast.—The plaster of Paris model of the statue of Bavaria, for the triumphal arch in the Ludwig Strasse, is now exhibited in the royal foundry, previous to being cast. With flowing garments and an onward look, she firmly grasps the reins of the four lions which draw the quadriga. This work was designed by M. de Wagner at Rome, by whom, assisted by his pupils, the model has been made. Beside the royal establishment, the iron foundry and machine manufactory of M. Maffei is next to be adverted to. Here, on a most extensive scale, the forging and casting of large works of art and utility are carried on, amongst which, some huge staircases and sepulchral monuments of Gothic style are conspicuous. The ornamented pieces for the inner roof-work of the round arches of the Munich *campo santo* (cemetery) are also cast here.

The Munich Art Union seems to have fallen into an egregious error. As many persons of the middle classes have joined it lately, the committee, thinking, probably, to do them a piece of courtesy, have made the subject of the members' plate, as general and every-day a thing as possible. It is not the aim of Art Unions to keep art continually on the same level, still less to debase it; on the contrary, it is the elevation of art and public taste which is their chief and legitimate province. So, after all, the above may be considered anything but a compliment, for which, at least, it seems to have been intended. The subject, therefore, for next year's prize plate is yet under contention.

Mountain-Relievo Exhibition at Munich.—The well-known engineer and geographer, M. Stoltz, has lately exhibited his relievo of Hohenschwangau in the conservatorium of the Topographical Bureau. It renders one of the most interesting parts of the mountains of South Bavaria with a correctness, which only repeated barometical admeasurements and the surveying of every detail could effect. The relievo of Tegernsee made by M. Stoltz previously, and on a larger scale, is equally interesting to the geographer and geologist.

Restoration of Ancient Canals in Russian-Caucasia.—The Russian Government have very praiseworthily begun the restoration of those canals of irrigation, which furrow the whole south-eastern portion of the trans-Caucasian provinces. Most of these canals were constructed by the kings of Armenia, and subsequently by the shahs of Persia and the sirdars of Erivan. The origin of some is even ascribed to the great historical monarch of ancient Asia, Semiramis, amongst which is one called Shamiram. What must have been the fertility of these countries—of which, however, history has preserved no record—may be guessed from the fact, that in one district of Eriven alone, there are to be seen 148 canals of great extent, which were the source for the further finding of 384 secondary branches. But the greatest part, and amongst them the very largest, present but a heap of ruins: which, however, by their stupendous development, attest the fertility and population of these now almost deserted *steppes*. All this, war, rebellion, and oppression, have swept away. Governor-General Prince Woronzoff is said to consider the re-construction of these ancient canals as a favourite idea, which would do an immense good to the inhabitants of Russian-Caucasia.

The new Haven of Swinemünde on the Baltic.—The Prussian Government is using great exertions for making this the "Havre of the North." The Oder has been corrected and regulated, and the harbour laid out and enlarged with great judgment, and at a great expense. The situation is very felicitous, as Berlin can now be reached in 9 hours, Copenhagen in 18, and St. Petersburg in 48. The number of vessels frequenting the harbour has increased during the last year to 1500, mostly English, with coals, &c.

Ancient Roman Canals.—The ingenuity and sucess of the Romans, not only in works of art, but also in objects of general utility, has lately become more apparent by the discovery of some canals in the famous Pontine swamps, used in ancient times for the drainage of this now unhealthy and barren country. According to the opinion of experienced engineers, it will require but little trouble to put them in complete repair, and make them again available for the purpose which they served 2000 years ago.

The Coal Mines of Hungary.—Coal has lately risen into great importance in Hungary, by the introduction of extensive steam communication in that country. The quality of coal in the Banat is said to be equal to the best English. For the purpose of properly opening the coal mines of Oravitz, Gerlistz, &c., an under-shaft is to be constructed, which will extend to the great length of 2,600 fathoms. For ensuring a proper ventilation, this tunnel will be 18 feet high, and occasion an expense of half-a-million of florins: but, when finished, will yield a yearly produce of two millions of chaldrons of coal. But for ascertaining positively, whether the seams of coal retain their size and quality down to the required depth, gigantic pits will be sunk in the Stewendorf mine, and coal and rock raised by steam engines of proportionate magnitude. For obtaining an easy outlet for such a mass of mineral, a railway will be constructed from Oravitz to the Danube. The iron works in these distant parts of Eastern Europe will receive a great impulse, as an astonishing number of rails is now in demand. Forges and tilt-hammers on a large scale will enliven those hitherto inactive and unproductive countries.

Restoration of the Harbour of Marsala, Sicily.—This harbour, one of the finest and best situated in that island, is to undergo a thorough restoration, by the voluntary contributions of the inhabitants of Marsala and some of the English houses engaged in the wine trade. An engineer has lately arrived to make the necessary surveys. The harbour is so fine, that the Arabs called it *Mars-Allah* (God's-haven), but John of Austria had it filled up after the battle of Lepanto. These obstructions removed, Marsala will double its commerce.

New System of Bridge Construction.—At the late Exhibition of French Industry, at Paris, M. Neville's model of a bridge, upon a new system, attracted much attention. The Belgian government has since taken up the subject, and experiments were made on the North Line. Two locomotives and their tenders were placed at the disposal of M. Neville, of the enormous weight of from 30,000 to 32,000 kilogrammes. They were made to pass the bridge, side by side, first at a slow and then at a rapid speed. The experiments, several times repeated, afforded the greatest satisfaction, as these heavy masses produced very little flexion in this comparatively slight structure; indeed, the flexions of the bridge, with an opening of 72 feet, did not exceed, even at the greatest speed of the engines, more than ⅜ inch in the middle. M. Van Esschen, engineer of the government railways, was under the bridge, to measure the flexion; and the persons on the bridge stated that the vibrations during the speediest transit were nearly imperceptible.

Steamers on the Caspian Sea.—Since July last, two iron steamers, of 100 horse power each, perform twice a month the journey between Astrachan and Baka, which occupies only two days. Thus, a person may now go from the Caspian to St Petersburg in 15 days. A railway, only for horse power, has also been opened between the Don and the Wolga.

Castle Wartburg, Saxe Gotha.—This castle, once the abode of Martin Luther, is undergoing a thorough renovation by order of the hereditary grand duke of Saxe Weimar. It is, after all, no easy task to restore such a huge building, erected at various periods of remote date—to pitch at the right ideas of the original builders, to omit nothing essential, and to produce a harmonic whole. This difficult task has been confided to M. de Quant, architect to the court of Prussia. For the sake of obtaining a correct idea of all the structures which have existed on the spot, the various foundations and walls have been laid open by extensive excavations. What has been already found is of great value and beauty. The middle façade of the court or square of the castle presents three stories of arcades, in the Byzantine style. A large quantity of rubbish and ashes of former conflagrations has also been removed, and several rows of Byzantine columns of good proportions, have been discovered on the eastern wing, and which will, when restored, exhibit a finer appearance than the more modern ones, as they are higher and of more slender modules. All the buildings which surround the large court are now exposed, and present a very different front and position than has been hitherto supposed. A staircase, hewn in the main rock, has also been discovered, leading to the baths of the ancient landgraves. The apartments of the landgravines appear to have been under ground, but are of large and fine proportions, each supported in the middle by a column, with a very fantastic capital, like those in the Remter, at Mareinburg. Some parts of the castle still appear as they did in olden times, as, for instance, the banqueting hall, which is adorned with portraits of former markgraves and landgraves. Close to it is the armoury, filled with figures of knights, on foot and on horseback. It is to be remarked, that permission has been given to inspect the castle at all times, so that visitors are even occasionally admitted to the rooms which the hereditary grand duke and his guests occupy—a liberality, after all, only possible in a small and not over-crowded town of Germany.

Kaulbach's Cartoon for the Berlin Museum.—This latest work of the great master has been exhibited at Munich, and is of the size of the picture of the Destruction of Jerusalem, by the same artist; but the work itself will be still larger. It is the first of a series of six pictures for the same royal establishment, and represents the "Division of nations at the building of the Tower of Babel." German periodicals expatiate much on the coincidence of the ideas of the artist with those of the modern German school of philosophy, and quote Schilling to prove the beauty of a cartoon. So far English art-criticism has not yet provided, and we can merely state that Kaulbach has represented Nimrod as failing in his over-reaching tendencies, that the people are driven forth from their unholy occupation—the tribes of Shem, Ham, and Japeth each powerfully and originally characterised by a splendid force of the crayon. Besides this force of the composition, that particular *naiveté* and sweetness of Kaulbach's works is also diffused over the whole cartoon—making the beholder long after the coluor-execution of such sublime thought.

The Earthquake in Italy.—This phenomenon has now ceased to exert its ravages, terminating with a few slight shocks. According to all experience, such undulations of the soil following a great earthquake, are the last throbbings of the volcaic powers, acting at an astounding depth. Tuscany had been, for ages past, free from such awful catastrophes as have lately visited it, and those formerly perceived were only the last eradications of the earthquakes of Sicily or Calabria, whose effects are always felt at great distances. The *Gazetta di Firenze* has given, of late, an accurate account of this phenomenon, by which it appears that the centre of the movement was the Colline, where it extended over a space of about 100 square leagues. In the former locality, the large villages of Lorcazana and Orciano resemble places demolished by the battering of cannon. The opinion generally received by geologists since the times of Dolomieu and Bertrand, that earthquakes and volcanic eruptions are contingent on very rainy seasons—the waters penetrating to the lower parts of the earth's strata, being there converted into steam—has not been confirmed in this case, the season having been a very dry one.

Academy of Sciences of Paris.—M. Lerebour the younger, one of the principal mathematical instrument makers of France, has forwarded to the Academy a volume, "On the chemical and apparent area of the objectives of the Dauguerreotype." M. L. states that he has succeeded in making these two areas coincide, and that the instruments which he has invented completely obviate the hitherto definitive coincidence. The Academy considered this a great improvement of the Dauguerreotype.—M. Faye, astronomer of the Paris Observatory, has also sent a memoir, entitled "Determination of the parallax or distance of the Argelander (the star 1,830 of Groombridge's catalogue) from the earth. In this fine essay, M. Faye has well combined theory and practice, and united elevation of mind with minutiæ of detail and correctness of observation. The result of his observations makes this star of the magnitude of 1″ 06, and at a distance from the sun of 190,000 middle distances of the earth from the sun; and, at the rate of 75,000 leagues per second, the light would require three years to arrive from the Argelander to us.

Diffusion of Sulphur over the Surface of the Globe.—M. Dumas mentioned in his memoir, the cascade which the Rio Vinagre forms not far from the volcano of Pareci, in Popanja. The observations of Humboldt and Boussingault have proved that this water contains free sulphuric and hydrochloric acids. An analogous phenomenon are the Lagoni of Tuscany—those open spiracles of the ground, where aqueous vapours constantly issue, and which contains, besides boracic acid, a considerable portion of sulphuretted hydrogen. Other phenomena of the kind are to be met with all over the globe. Sulphur also holds a great importance in the formation of all nitrogenous substances, animal and vegetable—constituting about the $\frac{1}{100}$th part of their weight. Thus 10 kilogrammes of dried nitrogen matter (which is about the weight of an ordinary sized person) contain 100 grammes. The quantity of sulphur, therefore, which is scattered over the globe, be it in a mineral or organic form, is very great. Messrs. Belfield—Lefevre, and Foucault have presented to the Academy an essay on their improvements of the Dauguererotype. "Hitherto—they say—the merely iodized plates have not been efficient whenever the diverse portions of the object to be represented possess notably different intensities of illumination; and thus, by the process hitherto pursued, the different portions of the plate could not appear with the tone corresponding to the respective intensity of illumination." The process consists in polishing and iodizing the plate as usual, and then to make it absorb vapours of bromine, three times the amount which has been hitherto considered the maximum of the susceptibility of the plate.

NEW CHURCHES.

St. Thomas, Winchester.—This church is nearly completed externally on a scale of great magnificence. The style is Decorated, and the eastern elevation exhibits a chancel and chancel aisles under separa-e gables. The new church has been built upon high ground, and its spire will have a very striking effect. The old church of St. Thomas having been found inadequate for the wants of the parishioners, the new edifice is to supply its place.

Christ Church, Portswood, Southampton.—Messrs. Brandon are the architects of this church, which is in the Decorated style, and consists of a chancel without aisles, and a nave with aisles, and a clerestory of quatrefoil windows.

St. Mark's, Swindon.—The Great Western Railway Company have built and endowed a handsome new Church. The architects are Messrs. Scott and Moffatt. It is gratifying to find a work like this entrusted to architects, who, we know, generally prefer real to showy architecture, and are incapable of using *papier machè*, or stucco, in the decoration of churches. The present edifice consists of a chancel and sacristy on its south side, a nave with aisles, a porch on the south side, and a tower and a tower and spire on the opposite side.

Wallingford.—The Chapel of St. John the Evangelist has been consecrated by the Bishop of Oxford.

Seer-Green, Bucks.—The recently consecrated church has been built by Mr. Deerson, in the early English style. The extreme length including the chancel, is 80 feet, the bell-turret is 60 feet high. The church is fitted with open seats throughout, and will accommodate 200 persons.

Chantrey, Somerset.—The Church of the Holy Trinity is another of the works of Messrs. Scott and Moffat, and comprises a nave with a porch on its south side, a chancel, sacristy, and bell-tower. The style is decorated All the windows are glazed with painted glass, by Mr. Wailes. Th seats are of oak, uncontaminated by varnish, the pulpit is of stone, the chancel is paved with ornamental tiles. There are stalls erected, not merely for ornament, but for actual use by the choir. This church ha been built at tne cost of a benefactor recently deceased.

St. Edmund's, Vobstor, Wells, is built by Mr. Ferrey in the Decorated style, and consists of nave, chancel, and sacristy, with lean-to roof. There will be neither galleries nor pews in this chapel.

St. Michael, Bissage, Gloucestershire, is a small structure built by Mr. Harrison in the Decorated style. The western tower will hereafter be crowned by a spire. The chancel is paved with encaustic tiles, and contains returned stalls. The pulpit is of stone and stands in the nave.

Darweston, Blandford.—Mr. Hardwick has rebuilt the church here at the expense of Lord Portman. There is a spacious chancel with an elaborate timber roof: the pulpit is of carved oak.

Stert Church having been almost rebuilt has been opened by the Bishop of Salisbury.

St. Mary's Flint. We regret to learn that this very ancient church is to be pulled down to make way for a modern structure.

St. Giles, Petworth is being rebuilt from designs by Mr. Billing in the early English style. The total length including the chancel is 90 feet. Over the porch is the south aisle is a low tower, the roofs internally are open.

St. Mary's Torquay a very fine Church, by Mr. Salvin. The nave has aisles and clerestory, and the chancel is terminated by an apse. On the south side of the nave is a tower. The effect of the interior is very imposing, and is not marred by an ostentatious redundancy of ornament. The west window consists of five lancets of which two only are pierced all the glass will be stained.

St. Paul, Alnwick is another spacious structure, by Mr. Salvin, and is built and endowed by the Duke Northumberland. The style is decorated. The plan comprises a lofty nave with clerestory and aisles, a chancel with aisles, and a high tower on west side. The east window i filled with flowing Decorated tracery. The stalls in the chancel scarcely deserve their name as they are not appropriated to their apparent use, but are simply superior pews for the Duke of Northumberland's family. When will dukes doff their dignities and privileges at the church-doors?

There appear to be about 400 churches in progress throughout the country, and almost every one is built in the style of our national architecture.

STEAM NAVIGATION.

The Oriental and Peninsular Steam Navigation Company.—The two new vessels which have been lately added to the Fleet of this Company, the Pottinger and the Ripon, have been fitted with steam engines on the oscillating principle, the largest we believe that have been as yet constructed; they are 76 inches diameter and 7 ft. stroke. Letters from the captain and engineer of the Pottinger have been received, the one from Gibraltar, the other from Malta: they speak in high terms of the performance of the engines, she passed through some very bad weather between England and Gibraltar. The Ripon went to sea without any trial of the engines, and although exposed to the most adverse circumstances for new engines, and having had her rudder-head washed off in the late heavy gales, there is not under all the trying circumstances to which they have been exposed, any fault to be found with her machinery, for, with the ship labouring in an unmanageable state in the trough of a heavy sea for some hours, the engines were never brought up, and continued to do their work all the time admirably. These satisfactory results prove that oscillating engines of any power may be used for marine navigation, by which there will be a saving in space and weight.

The Capri and the Vesuvius.—These two new steamers have been built for the Neapolitan Steam Navigation Company, by Messrs. Ditchburn and Mare; they are constructed of iron, and are 189 feet long, and feet beam, and 600 tons burthen, with steam-engines of 220 horse-power—double cylinder by Messrs. Maudslay and Field. At the trial of the Capri down the river Thames, at Long Reach, it is stated that she attained a speed of 17 miles per hour. The vessel is elegantly fitted up, and promises to be a clipper.

The Sphynx Steam Frigate.—This war steamer is a vessel of 1200 tons, fitted with a pair of oscillating steam engines of 500 horse power, by Messrs. Penn and Co.; the cylinders are 82¼ inches diameter, and 6 feet stroke, and fitted with double slide valves. When she made her experimental trial down the river Thames last month she was laden with 350 tons of coal, and all her stores for 12 months, and provisions for 3 months; her draught of water was 14 feet 1 inch forward, and 15 feet 1 inch aft. It is stated that she ran an average speed of 13 miles an hour, and made 14½ revolutions per minute, with the floats of the paddle-wheels deeply immersed. The great success which those engines have attained, as well as those of the Pottinger and Ripon, also fitted with oscillating engines, by Messrs. Miller and Ravenhill, and of about the same power as the Sphynx, clearly show that oscillating engines of any power may be as easily constructed and adopted for marine purposes as fixed cylinders.

New Holyhead Packets.—The Admiralty have contracted for four new steam packets for the Holyhead station. One to be built by Messrs. Ditchburn and Mare, it is understood, on the lines of the Surveyor of the Navy, engines by Messrs. Seaward and Co.; one of wood, on the lines of Mr. O. W. Lang, with Penn's engines; one, engines and vessel by Messrs. Miller and Co.; and one vessel by J. Laird, the engines by Forester, of Liverpool. They are to be called the Caradoc, Llewellyn, the Kathleen, and the Banshee.

The *Janus*, steam-sloop, Lord Dundonald, will be ready by the beginning of the year to make a final trial, the Admiralty having granted 1000*l*. to make the necessary alterations.

The *Medea*, steam-sloop, on the 6th ult., proceeded down the River Thames to test the engines, at the mile in Long Reach. Her speed on the first trial was 8·889 knots against the tide, and 13·094 with it, giving an average of 10·991, but on subsequent trials she made more than eleven knots. She had on board about 190 tons of coal. Her draught of water was 13 feet forward, and 13 feet 5 inches aft. Her engines, which were supplied by Messrs. Maudslay and Field, were in excellent working order, and made 24 revolutions a minute.

Screw Propeller.—A series of interesting experiments on the powers of the various screw-propellers, and the best mode of fixing them in steamers, have been carried on and are still in progress with the Dwarf, steamer, which has been set apart for these experiments. The first trial was made with the common Archimedian screw (Smith's patent), and the results were as favourable as those exhibited by any subsequent invention. The next trial was made with Rennie's screw, but the results, in this instance, were not so satisfactory. A third trial was made with Hodgson's parabolic propeller, and, up to the present time (for this invention is to be again tested) the success was equal to that of the common propeller. A fourth trial will soon be made with Woodcroft's patent, constructed upon a new plan of shifting the angles of the screw to the most favourable position, with the view of determining the best angle of impingement. Some trials have also been made by altering the dead wood of the Dwarf, so as to resemble the square sterns of the old block ships; but in this case it was found that the screw could scarcely give the vessel tideway.

The *Teazer*, a small iron steamer, with engines of 100 horse power, and fitted with the screw-propeller, was tried again on Nov. 16, at the mile in Long Reach; her engines, which are on the vibrating principle, by Miller and Ravenhill, attained a maximum number of nearly sixty revolutions, but she did not make very rapid progress, the stern of the Teazer being square, which is apparently the worst form for the action of the screw propeller.

It is the intention of the Lords Commissioners of the Admiralty that, in future, the engineers in steamers shall be considered as ward-room officers. The alteration is most creditable to the board.

The Effects of Shot on Iron Vessels.—The information received from the officers of the Gorgon steam vessel, which has lately arrived from La Plata, gives a very alarming account of the effect produced on the hulls of the Harpy and Lizard iron steam vessels by the shot from the batteries of Rosas. It was expected, from the nature of the material, that any breach made by shot would leave a clean fracture, merely curling up the lips of the orifice, as is usual when fractures are caused in iron by the application of an ordinary force. The results, however, are quite different. Instead of a clean fracture, large splinters of iron flew about in all directions on the hull being struck, rendering the danger from this cause tenfold more imminent than that produced by the shot itself. Several splinters of this kind, struck from the hull of the Harpy, have been brought home by the officers of the Gorgon, and, amongst the rest, the splinter from the angle iron which caused the death of poor Mr. Barnes, the clerk in charge, proving that the tendency to splinter is not confined to the thin sheet iron of the hull, but to the heavier masses which compose the vessel. These results are in accordance with those observed in the experimental trials on board the Excellent, and they constitute a sad drawback against the general use of iron as a material for vessels of war. Whether the iron in question is not so malleable as it ought to be, or might be if better wrought, is another question; for the present, however, the men are alarmed, and those who have witnessed the effects produced on board the Harpy, declare that they will never go to sea in an iron vessel.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM OCTOBER 22, 1846, TO NOVEMBER 21, 1846.

Six Months allowed for Enrolment, unless otherwise expressed.

Etienne Abraham Maccaud, of No. 1, Place de la Madeleine, Paris, mechanician, for "Improvements in lamp and gas burners."—Sealed Oct. 22.

John James Alexander Maccarshy, of Sidney-terrace, Brompton, gentleman, for "certain Improvements in anchors and fids for masts of vessels."—Oct. 22.

William Anderson, of Clitheroe, Lancaster, for "certain Improvements in machinery or apparatus, for preparing and spinning cotton, and other fibrous substances."—Oct. 22.

John Paterson Reid, of the city of Glasgow, and Thomas Johnson, mechanic, for "certain Improvements in machinery for weaving, and for producing patterns in weaving, as also in machinery, for finishing certain woven fabrics."—Oct. 22.

James Thomas Jullion, of Stratford, chemist, for "Improvements in the manufacture of certain acids, also improvements in decomposing certain acids, and applying the products resulting therefrom, to the production of certain chemical compounds."—October 22.

James Lysander Hale, of Hackney, Middlesex, civil engineer, for "certain Improvements in sewerage and drainage, and apparatus connected therewith, parts of which are applicable to steam engines."—Oct. 22.

John Hutton, of Commercial-road, East, chronometer-maker, for "certain Improvements in chronometers and other time keepers."—Oct. 22.

Henry Mapple, of Child's-hill, Hendon, Middlesex, machinist, for "Improvements in apparatus for transmitting electricity between distant places, and in electric telegraphs."—Oct. 27.

William Crane Wilkins, of Long Acre, Middlesex, for "certain Improvements in lamps, and apparatus connected therewith, parts of which are also applicable to the raising of water."—Oct. 29.

William Reid, of Saint Pancras, Middlesex, engineer, for "Improvements in the manufacture of wire."—Oct. 29.

Noel Etienne Aime Paret, of Lyons, in the kingdom of France, gentleman, for "Improvements in finishing silk, cotton, and other fabrics, and in heating apartments."—November 2.

Henry Headley Parish, of Chesham-street, Middlesex, Esq., and Samuel Rootsey, of Portland-square, Bristol, Esq., F.L.S., for "Improvements in supplying and purifying water."—November 3.

George W. Eddy, of Waterford, in the State of New York, of the United States of America, for "an Improvement in the manufacture of cast metal wheels for railway and various other carriages."—November 3.

Baron Charles Wetterstedt, of Rhodes Well Road, Limehouse, Middlesex, for "Improvements in the manufacture of sheet metal, for sheathing and other purposes, in preventing the corrosion of metal, and in the preservation of wood and other materials."—November 3.

William Exall, of Reading, in the county of Berks, engineer, for "Improvements in the construction of wheels, and in certain implements or tools employed therein, and in the mode of forming and manufacturing the tyres of wheels, which mode is applicable to making metallic rings, bands, hoops, cylinders, and other similar articles."—Nov. 3.

Alfred Vincent Newton, of Chancery-lane, mechanical draughtsman, for "certain Improvements in the manufacture of driving bands, part of which improvements are also applicable to the manufacture of other fabrics." (A communication.)—November 3.

Gaetan Bonelli, of Milan, engineer, for "Improvements in bridges, viaducts, aqueducts, and other similar erections."—November 3.

Matthew Lealny, of Great George-street, Westminster, civil engineer, for "certain Improvements in steam engines."—November 5.

Robert Teagle, of Hammersmith, plasterer, for "Improvements in chimney pots, and in apparatus for cleansing chimneys."—November 5.

David Barnett, of Birmingham, merchant, for "new or improved instruments or machines, for effecting or facilitating certain arithmetical processes or computations." (A communication.)—November 5.

Frederick Herbert Maberly, of Stowmarket, clerk, Thomas Branwhite, of Eattlesden, millwright, and Dennis Lusher, of Great Tinborough, farmer, for "Improvements in machinery for obtaining and applying, and for accelerating and for retarding motive power, and for giving notice of alarm in expectation of, or in actual danger."—Nov. 5.

Henry Henson, of Hampstead, in the county of Middlesex, gentleman, for "a new fabric suitable for goods, wrappers, wagon covers, and other like purposes, and certain processes in the manufacture of the same."—November 5.

Thomas Yates, of Preston, Lancaster, watchmaker, for "Improvements in time keepers."—November 12.

John McBride, of the firm of McBride and Company, cotton spinners and power loom cloth manufacturers, Albyn Works, Glasgow, for "Improvements in weaving."—November 12.

William Bridges Adams, of Old Ford Lane, in the county of Middlesex, engineer, for "Improvements in the construction of wheel carriages and engines moved or retarded by animal or mechanical agency, parts of which improvements are applicable to other like purposes."—November 12.

Louis Hypolite Piaget, and Phillip Henry Du Bois, of Wynyatt-street, Clerkenwell, for "Improvements in producing ornamental surfaces."—November 12.

George Smith, of Camborne, in the county of Cornwall, safety fuze manufacturer, for "a new safety fuze."—November 12.

Edward Staite, of Peckham, in the county of Surrey, gentleman, for "certain Improvements in lighting."—November 12.

George William Jacob, of Hoxton, in the county of Middlesex, printer, for "a new manufacture of printed, patterned, ornamented, coloured, embossed, and moulded surfaces."—November 12.

John Healey, of Bolton, in the county of Lancaster, machine maker, for "a new and improved woven fabric, and also certain improvements in machinery for producing the same."—November 17.

Thomas Masters, of Upper Charlotte Street, Fitzroy-square, Middlesex, confectioner, for "Improvements in apparatus and means for cooling liquids and matters, and filtering and preventing liquids freezing."—November 17.

Bartholomew Benlowski, of Bow-street, Covent Garden, Middlesex, gentleman, for "certain Improvements in the apparatus for, and process of, printing."—November 17.

William Eaton, of Newington, in the county of Surrey, engineer, for "certain Improvements in obtaining motive power."—November 17.

Robert Brett Schenck, of the city of New York, in the United States of America, gentleman, for "certain Improvements in the preparation of hemp and flax." (A communication.).—November 17.

Christopher Robson, of Newcastle-upon-Tyne, grocer, for "Improvements in machinery for dressing fruit."—November 21.

James Denton, of Greenacres Moor, Oldham, Lancaster, mechanic, for "Improvements in certain parts of machines used in the preparation for the spinning of cotton, wool and other fibrous substances."—November 21.

James Barsham, of Bow, Middlesex, manufacturer, for "Improvements in manufacturing brooms and brushes."—November 21.

William Pidding, of North Crescent, Bedford-square, Middlesex, gentleman, for "Improvements in carriages."—November 21.

TO CORRESPONDENTS.

PYNE on "Perspective," "City, Town, and County Architecture," "Railways for the many—not for the few,"—Received.

"*Six Years' Subscriber.*"—Perhaps the best account of the details of the Steam Engine is to be found in the Treatise of the Artizan Club, but a systematic and satisfactory work on the Steam Engine remains among the desiderata of Engineering Literature.

END OF VOLUME IX.